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Putting the Final Touches on a 200-times-magnified model of a strange sea animalcule

FLOWERS AND TINY ANIMALS IN GLASS **(See page 296)**

Prosthesis of the Lower Limb

A Summary of British Experience and Practice

BEFORE the war amputations of the limb were becoming rare; now the number of British sailors and soldiers requiring an artificial leg is about 40,000, a number sufficiently large to give rise almost automatically to inquiries as to the construction of artificial limbs. Although the problems presented by artificial limbs have not been completely solved in the case of the lower limb, a considerable measure of agreement as to the modes of their solution exists; for this reason the following article is limited to the consideration of this part of the subject.

CONDITION OF THE STUMP.

Before an artificial limb can be fitted the stump must be in a suitable condition for wearing a limb. Owing to the unfavorable conditions under which many of the primary amputations have been performed subsequent trimming operations (or rarely re-amputations) are necessary in the majority of cases. At the beginning of the war 90 to 95 per cent. of amputation stumps seen at a German limb-fitting hospital required a second operation to render the stump painless and capable of wearing a prosthesis, but this proportion during the second year of the war diminished to 75 per cent.

The stump must be covered with sound movable soft parts which, however, must not be excessive in amount, especially if any part of the weight of the body is to be borne on the end of the stump. Excessive mobility of the soft parts of a stump is detrimental. The mobility is brought about by the surgeon, instead of fixing the muscular aponeuroses to the end of the bone, suturing the flexor and extensor masses to each other across the end of the bone and healing taking place without adhesion between the aponeuroses and the bone. When the patient attempts to move the stump the first effect is the movement of the scar to and fro over the end of the bone. When a limb is fitted and the patient tries to walk much power is lost by this movement.

The scar should be thin, movable, and neither eczematous nor ulcerated. Ulceration of the scar often results when a guillotine amputation (usually performed as a temporary measure) is not followed by a re-amputation; the fibrous scar resulting often gives rise to trouble. On flexion of the artificial limb the soft parts of the stump are dragged up, thus interfering with the nutrition of the scar.

When the skin flaps are voluminous a troublesome eczema of the skin is sometimes seen. The skin is usually adherent to the bone; the condition is usually the result of a secondary operation performed while the tissues were in too septic a condition to allow of primary union. Scars over the end of the bone do not always prevent the use of an end-bearing pad.

A posterior scar is to be preferred in all amputations of the thigh and leg where considerable pressure has to be borne by the front of the lower end of the stump when the artificial limb is lifted or swung forward.

Although the best end-bearing stumps are those in which the section has been made through cancellous bone, end-bearing is possible when the section has been made through the compact bone and medullary cavity of the shaft. In the lower part of the leg the area of bone is too small to permit of end-bearing; in view of the fact that a stump of 7 to 9 inches in length affords sufficient leverage re-amputations are often permissible in this region.

Outgrowths of new bone-forming spurs rarely give rise to trouble; they are seldom large except in the thigh, when they are usually found at the inner side of the end of the bone, a situation not exposed to much pressure.

Other conditions obviously requiring treatment before the fitting of a limb include painful nerves and the presence of sinuses. If necessary surgical measures must be taken to render the movement of the joint above the site of amputation as free as possible; daily passive extension of the hipjoint as soon as the condition of the wound allows does much to prevent a deformity commonly found.

PROVISIONAL APPLIANCES.

Universal opinion in Germany, Austria, France, and Belgium is in favor of the use of a provisional limb as early as possible; the use of crutches is not allowed any more than is inevitable. The disadvantages of crutches include the danger of crutch palsy, the alterations of balance caused by the long use of only one leg, and the loss of power in the muscles of the stump. Besides preventing these disadvantages the use of a provisional limb also prevents pain and stiffness of joints; the circulation in the stump is improved, healing and shrinking are expedited, and end-bearing promoted.

In the case of the lower limb the provisional appliances often take the form of a Thomas's knee splint attached to the body by a suspender passing over the shoulder on the sound side. Flexion of the hip is assisted by the use of a strap attached in front to each side of the splint. The stump is encased in a plaster socket in which the sides of the splint are incorporated. Professor Mommsen uses a plaster socket and fastens to it the finished artificial limb.

Provisional appliances can be used five or six weeks after the amputation.

CONSTRUCTION OF THE BUCKET; MATERIALS USED.

The first point to consider in regard to the artificial lower limb is the construction of the bucket. No definite conclusion has yet been reached as to which is the best material. Although at present in practically every instance the bucket is made of wood or of leather, strengthened with steel supports, both these materials have disadvantages which prevent their being ideal. Leather has a tendency to "give"; the shrinking of stumps after fitting prevents a cavity carved out of the interior of a wooden block to fit a stump in its earlier condition from being satisfactory at a later stage.

Experiments are being made as to the suitability of other materials. The value of such different materials as plywood and glue, combined with muslin bandages, is being tested. A specially prepared liquid glue is well worked into the muslin bandage while it is being wound round a plaster-of-Paris cast. When dry the surface is rubbed with sandpaper and varnished. The material, it is claimed, is equal to celluloid or acetone, but is very considerably cheaper; it is light, strong, non-flammable and, when varnished, practically impervious to moisture. At La Panne Dr. Martin is experimenting with wood shavings and glue. With a plaster model of the stump as a foundation, he glues together several layers of beechwood shavings, each layer being arranged in a different direction. The glue is especially prepared with the object of rendering it impervious to moisture.

The great advantage afforded by the use of wood is the independence of the external form of the limb of the shape of the socket; this feature is not presented by any other material used in the construction of limbs. Of the various woods used for the purpose, willow is the most popular in England and America. It combines the maximum of strength with the minimum of weight; in addition to being pliable it has the advantage of not undergoing any change of form under the influence of changes in the humidity of the atmosphere. Seasoned wood is best, but unfortunately owing to the greatly increased demand kiln-dried wood must now be largely used; this method of drying increases the liability of the wood to crack.

METHODS OF FITTING THE BUCKET.

At Roehampton House the process of making artificial limbs can be seen from start to finish. The trunks of willow are sawn into appropriate lengths for thigh and leg pieces, the bark trimmed off, and the block roughly hewn to its future shape. If intended for a thigh bucket the central portion of the block is "pulled" (drilled out) by a machine. The shapes of the top and bottom of the bucket are roughly outlined on the ends of the block and superfluous portions removed by a band saw.

Various methods are used to ascertain the dimensions of the stump. Plaster casts are still held in favor by some fitters; the stump is bandaged with plaster-of-Paris bandages and allowed to set; with this as a mould a cast is made. Certain precautions are necessary: To reproduce the form of the stump, when wearing a bucket, as accurately as possible the stump is bandaged with the patient in the erect position. To reproduce the alteration of form caused by pressure on the end and sides of the stump by the end-bearing and bucket, a sock is worn over the stump and pulled up tight before the bandage is applied. Care is taken to mould the plaster well on to those points on which pressure is borne; in the case of the thigh the fist brings pressure to bear just below the ischial tuberosity. When the interior of the socket is being "pulled" trial is made from time to time of the progress by inserting the plaster cast.

Other fitters work "in profile"—measurements are taken, including the length of the stump and its circumference at different levels; a diagram is sometimes made by carrying a pencil along the inner and outer sides of the limb and stump when the patient is resting with his limb in the horizontal position over a piece of paper. The size and shape of the section of the stump at different levels are reproduced in a set of "charts" made of flat pieces of leather or metal, the outline of each chart being a reproduction of the form of the stump at the corresponding level; with these to help him to determine the desired shape the maker "pulls" the interior of the rough bucket.

ADAPTATION OF BUCKETS FOR VARIOUS AMPUTATIONS.

Certain amputation stumps, including those resulting from a Stephen Smith and Syme's amputation, are practically always covered with a leather socket. In these cases plaster casts are made, or limb and stump are reconstructed in wood from measurements; on these casts or lasts the leather is moulded. Workers "in profile" claim that they succeed in producing a bucket which grips the stump more closely than when the size of the socket is determined by the insertion of a plaster cast. In the case of a below-knee stump the lateral diameter of the limb is greater opposite the head of the fibula than at the higher level through the knee-joint; if made by cast the diameter of the top of the bucket must be equal to the greatest diameter of the interior, so as to permit the introduction of the cast; in these cases a gap is left between the stump and the inner surface of the socket above the level of the head of the fibula.

In the case of a thigh stump a considerable alteration in the form of the inner surface takes place when the limb is used for walking; contraction of the abductor muscles, especially the adductor longus and adductor magnus, then occurs.

In a recent amputation of the leg of a well-developed man the head of the fibula and the anterior tuberosity of the tibia are not prominent, but soon become so as the stump shrinks. If allowance is not made for these projections they give rise to troublesome bursæ. The plaster mould then gives an impression of the stump in its present form; by altering the "charts" or "lasts" slightly to correspond with the size and shape that experience has shown will within a comparatively short time be assumed by the stump a better permanent fit, it is claimed, is produced.

The shape of the top of the thigh bucket is determined by the ischial tuberosity and the anterior part of the perineum. The ischial tuberosity is the only bony point on which pressure can be borne; to ensure that the tuberosity rests on its upper border the bucket is so constructed that the diameter at this point is less than the diameter of the limb.

The anterior part of the perineum is unable to bear pressure; the bucket must be cut down to clear this part.

In a limb for a thigh amputation the roughly made thigh bucket is "keyed" on to the knee-piece, to which is attached the leg-piece and foot with the boot on; the patient is fitted at least twice while the limb is in the rough state.

OTHER POINTS IN REGARD TO THE BUCKET.

The tendency of all wooden buckets to crack is in the case of the American limbs prevented, or at least the cracking is localised, by the use of a thin covering of raw hide. This membranous covering is thoroughly wetted and spread evenly over the whole of the outer surface of the bucket, exposed to the action of heat, and then varnished; the result is a transparent covering, the presence of which can only with difficulty be detected.

The Hanger bucket is further strengthened by the insertion of screw wires tangentially to the inner surface at levels where experience has shown strengthening is required; in the case of the thigh these wires are inserted at a distance of 1 inch or 1¼ inches from the edge of the socket.

A ventilation hole is always provided below the end of the stump; above this hole comes the end-bearing pad, usually made in the form of a net of intercrossing leather laces fastened through small holes to the side of the bucket.

The average life of an artificial lower limb is about three years. In the case of the first limb worn this depends to a considerable extent upon the rate of shrinking of the stump. Every patient wears at least one stump sock; these are of uniform thickness and

*From *The Lancet*.

obtained through the limbmakers. If shrinking of the stump causes the socket to become too large another sock is added. The limit is usually reached when the man is wearing five or six socks; the bucket is then lined with leather, and if this does not suffice must be renewed. As a rule the stump ceases to shrink by the end of two years after amputation, but occasionally shrinking may continue as long as seven years.

THE KNEE-JOINT.

Other parts of the prosthesis will now be described. In the construction of the knee-joint it is essential that the bolt should be placed behind the centre of gravity of the anatomical joint. If the axis of the artificial joint corresponds in position with the anatomical centre a slight degree of flexion of the knee brings the line of action of the body-weight behind the axis of the joint, when further flexion must occur. If the axis of the joint has been displaced posteriorly the weight of the body falls in front of the axis and tends, instead of producing further flexion, to lock the knee.

The distance the axis is set behind the centre of gravity of the joint depends upon the particular leg-maker. Perhaps the usual distance the axis is set back is between ⅛ and ¼ inch; this amount, while allowing a sufficient margin of safety, does not interfere with the naturalness of the gait. If the axis is set further back the patient, when bringing from the flexed to the extended position, swings his foot in a slightly longer arc, causing the action to appear unnatural.

During weight-bearing the rigidity of the knee-joint is secured by the simple means of mounting the foot in a position of equinus. When the artificial limb is swung forward to take a step the heel comes in contact with the ground first; then, as the leg becomes vertical, the entire sole lies flat on the ground; with the foot in equinus this position is to all intents and purposes only possible when the knee is hyper-extended. When, therefore, the sole of the foot slopes obliquely downwards and forwards and the weight is taken on the toe the weight of the body acting vertically downwards tends to force the lower end of the thigh-piece into the hyper-extended leg-piece and prevent any movement of the two parts on one another.

As the thigh-piece is attached to the leg-piece by means of a spindle which passes through a metal eyelet hole projecting upwards from each side of the leg-piece, the action takes place between the spindle and the sides of the hole rather than between the surfaces of the thigh and leg pieces.

An arrangement must be provided to extend the leg-piece on the thigh at the apropriate phase of the step. The patient on raising the foot of the artificial limb to take a step raises and moves the limb forward by active flexion of the hip-joint; the weight of the leg-piece causes it to assume a vertical position, and thus bends the knee-joint. But during the weight-bearing phase the leg-piece must be in a vertical line with the thigh-piece. The change of the leg-piece into this position is effected by the action of gravity; when the patient is supporting himself on his sound limb the weight of the artificial limb causes it to swing forward like a pendulum. This movement is, however, both slow and incomplete. Some patients learn to supplement this pendulum movement by flexing the thigh slightly as soon as the foot touches the ground, but although this may suffice when the stump is long and the leverage in consequence powerful, in most cases some mechanism is required to prevent a mechanical gait.

Control of the knee is effected by cords pulling on the front end of a short lever which has the knee-bolt as a fulcrum, the posterior part of the lever being attached to the back of the leg-piece or the foot. Two cords are provided; these run over a roller and are hooked on to the front and back ends of a double suspender passing over both shoulders. When the patient raises his leg from the ground the weight of the appliance makes the cords tense; the pull on the front of the lever extends the leg-piece. By bracing up his shoulders as he throws his limb forward the patient can assist in the extension of the leg. The object of the roller is to do away with to-and-fro movements of the suspenders across the shoulders.

The "knee control" used in the Hanger leg allows of an alteration of the rapidity with which the leg is extended. By tightening the suspender, the distance of the end of the lever from the fulcrum can be altered; a hinge-joint in the lever enables this alteration in length to be effected.

A knee-locking device must be provided for patients who by reason of shortness of the thigh stump are unable to control the movements of the knee-joint, or whose daily life entails much going downstairs or walking downhill. In its simplest form the knee-lock consists of a piece of stout wire running along a canal in the outer side of the bucket; this wire can be pushed down between the knee-piece and the inner surface of the leg-piece, which is guarded at this part by a metal plate; the thick wire serves as a wedge between the two parts and prevents movement.

An automatic knee-lock has been devised by Mr. F. H. Critchley, of Liverpool. The joint consists of a very narrow barrel attached by side-irons to the thigh-piece; circumferentially to this is placed a cylinder of metal attached to the central tube of the leg-piece. The circumference of the barrel is gripped by a band-brake tightened by the pull of a rod attached to the heel. When the weight of the body is thrown on the toe-piece the foot rotates at the ankle-joint, depressing the heel, thus pulling on the rod and locking the knee-joint. This action takes place no matter what the position of flexion of the knee when the weight of the body is placed on the artificial limb. When the pressure is no longer exerted on the foot, the knee-joint automatically becomes loose and the leg-piece free to swing. The band normally tends to open by its own resilience, but a compression spring is usually added to ensure the opening taking place. The range of movement of the knee-joint is limited by an external stop.

THE ANKLE JOINT.

A movable ankle-joint is now almost universally used, but the movements are commonly limited to those of flexion and extension. With the boot on, the part of the foot representing the articular surface of the ankle-joint is horizontal. The surface of the leg-piece forming the front of the joint is inclined at an angle of 15° with the ground, the back part at an angle of 30°. The wider posterior angle renders possible the degree of flexion of the foot required when the patient walks downhill.

The following describes an arrangement in common use. On the upper surface of the foot two cavities are hollowed, one in front of, the other behind, the bolt of the ankle-joint; in each of these cavities is placed a cylinder of rubber, the posterior about twice as high as the anterior. On these cylinders rests the leg-piece, ending in front in a short instep lying within the cavity hollowed out in the foot. The foot is attached to the leg-piece by a bolt made in the form of an inverted T; the base formed by a steel tube which fits into two corresponding grooves in the leg and foot is attached to the leg by the vertical part, a rod which is secured by a nut at the bottom of the hollow of the leg-piece. Upon the steel tube moves a steel U-shaped staple, the two ends of which pass through the foot and are fastened in position by two nuts secured by a locking-nut.

The ankle-joint must be kept tight enough to prevent any side motion, but not too tight to interfere with the movements of flexion and extension. The freedom of movement of the joint can be altered by tightening the nuts and compressing the rubbers, or *vice versâ*, or by altering the size of the rubber buffers. If the locking-nut is not kept in position the foot works off and breaks.

THE FOOT.

The foot is now usually made of wood. To allow of its bending when the patient comes forward on the front part of the foot for the next step the foot is divided transversely at a level corresponding to the middle of the metatarsal bones. The front part is attached by a dorsal and plantar piece of leather or rubber reinforced by wire; between the two parts are two rubber cylinders which, when the limb is at rest, keep the toe-piece extended at an angle of about 15°, but allow of extension to 45° when the foot is pressed on the ground.

As mentioned above, the foot is mounted in the equinus position; the heel is 2 or 3 cm. off the ground, the usual height of the heel of a boot. The foot should point slightly outwards, as in the normal standing position, the usual angle being 18.5°.

AMPUTATIONS THROUGH HIP-JOINT AND UPPER THIGH.

Special considerations for each amputation remain to be dealt with. For amputations through the hip-joint the "tilting table," perfected during the war, is the most satisfactory appliance. It consists of a leather socket moulded round one-half of the pelvis, reaching upwards as high as the iliac crest and attached to the trunk by a pelvic band. The pelvic band is a steel girdle which rests on the iliac alæ and extends a short way in front of each anterior superior iliac spine; it is covered with leather and buckled together in the front. The metal is moulded to the patient's body while in a soft state, and is then tempered. To the socket an artificial limb is attached by steel supports.

To enable the patient to bend the limb at the level of the hip-joint when he sits down a hinge-joint with a spring lock is placed in the outer steel support; this joint automatically locks when the patient rises, enabling him to walk with a rigid leg. On the inner side the steel piece runs around on a quadrant fastened to the under surface of the leather socket.

The "tilting table" has also proved to be the most suitable appliance for high amputations of the thigh, leaving a stump of less than 7 inches in length. These stumps are often incurably flexed and abducted; also the patient with so short a stump is unable to control an artificial limb. When wearing this appliance the patient sits on his flexed stump, the end of which protrudes slightly through a hole in the front of the moulded socket.

If a patient with an amputation of the thigh has difficulty in controlling the artificial limb, a pelvic band should be fitted. A properly fitted pelvic band not only ensures firm fixation of the limb, but also prevents eversion of the foot and rotation of the bucket.

AMPUTATIONS ABOUT THE KNEE.

A complete end-bearing is often possible in the case of amputations through the condyles of the femur, disarticulations of the knee, and very short stumps below the knee.

If a wooden bucket is to be worn, owing to the bone at the lower end of the stump being larger than at a higher level a modication of the bucket is necessary to ensure its gripping the stump firmly. The front of the lower half of the bucket is cut away and the wood replaced by leather, which laces in the middle.

When a transcondylar operation has been performed before the plaster mould is made it is as well to pad the edges of the cut femur. The length of the stump does not leave sufficient room for the use of a knee-bolt; movement of the knee-joint is permitted by two hinged side-steels identical with those used for below-knee amputations; these steels lock dead tight when the knee is in the position of extension.

AMPUTATIONS THROUGH THE LEG.

A wooden socket can be fitted to amputations through the leg if the stump is at least 6 cm. long, if the knee-joint moves freely and can be fully extended by the patient, and if no adherent scars are present round the tuberosities of the tibia. The wooden bucket is fitted accurately to the head of the tibia and to the lower portion of the patella; it must grasp the tuberosity of the tibia firmly. The patellar tendon is capable of weight-bearing. Care must be taken lest the bucket press on the head of the fibula.

The shape of the top of the bucket is important. To avoid nipping the flesh between the upper edge of the bucket and the lower end of the thigh corset, both these edges must be concave; a concavity of a finger's breadth below the axis of the joint suffices. The back of the socket is flattened; if hollowed out too much at this point the stump is tilted forward and the flesh at the back of the knee pinched.

The leg is usually attached to the thigh by a leather corset; side steels, hinged at the knee, connect the corset and socket.

The shorter the stump below the knee the larger the bearing surface, and therefore the better the end bearing; but on the end of any round stump, provided an adherent scar is not present, a part of the weight of the body can be borne. Occasionally it is found necessary to fit a leather thigh bucket reaching up as far as the ischial tuberosity, which bears part of the weight.

The wearing of braces increases the stability of the limb and allows of looser lacing of the thigh corset, with the consequent advantage of freer movement of the thigh muscles. The braces pass over the shoulder of the sound side and are attached either to the thigh corset or the leg-piece. If the stump is short it is an advantage to attach the brace to a strap from which two branches pass down in the form of an inverted V and are fixed to the front of the leg-piece.

In the case of short stumps a leg socket should be fitted whenever possible; with the kneeling leg the gait of a patient is much less natural than when a socket is worn. When the patient has to walk on the bent knee a moulded leather bucket is provided, similar to that used for transcondylar amputations; a posterior band passing over the end of the flexed stump helps to keep the artificial limb in position.

SYME'S AND CHOPART'S AMPUTATIONS.

In a Syme's amputation the end of the stump should be able to bear the weight of the body. The stump is usually fitted with a leather bucket strengthened with steels, usually four—an external, an internal, and two anterior; it rests on a cushion within the bucket. An elastic strap is attached to the top of the instep and above to each side of the front of the socket.

If the end of the stump remains sensitive the patient must wear a leg bucket, embracing the head of the tibia. In rare instances a thigh corset, with side steels jointed at the knee, must be worn.

(*Continued on page* 304.)

Keeping the Propeller Dry

The Use of Aluminum Leaf in Making Wood Proof against Moisture

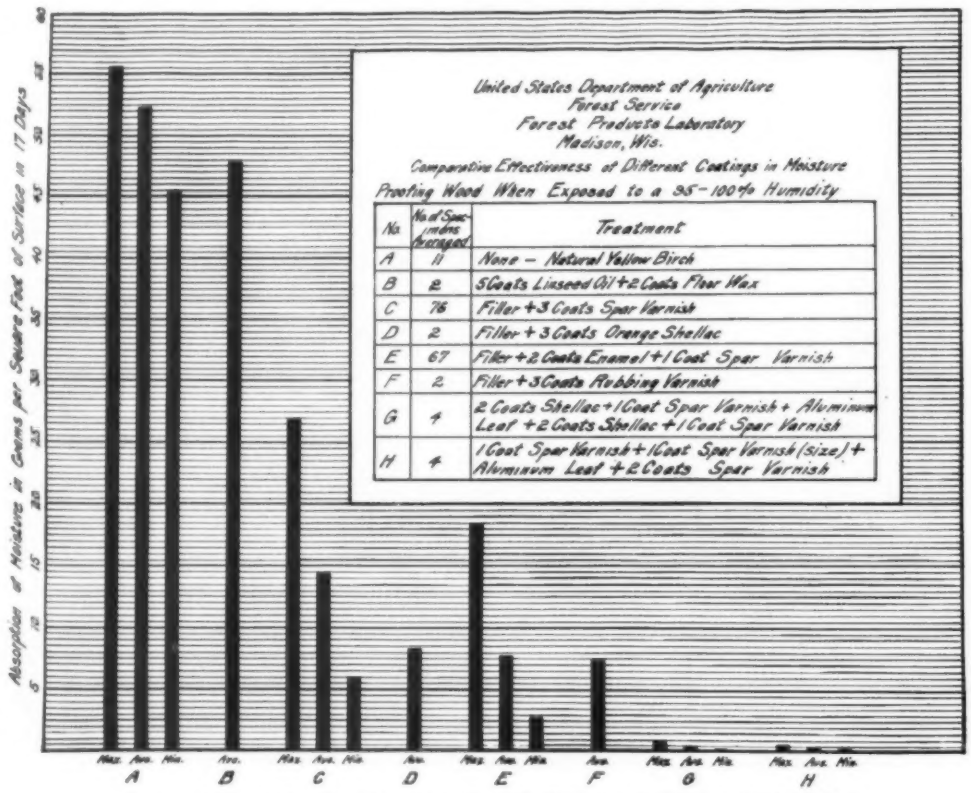
By M. E. Dunlap, U. S. Forest Service

In spite of its variability and some properties undesirable in a propeller material, wood seems to be the most satisfactory material for airplane propellers. The successful use of wood, however, depends upon overcoming or at least reducing to a minimum the effects of these undesirable properties, of which perhaps the most important is the tendency to shrink and swell with changes of moisture content.

It is well known that wood is a hygroscopic material; that is, it retains a certain amount of moisture, this amount varying with the relative humidity under which the material is stored. For instance, wood stored out of doors in the northern states will retain from 10 to 12 per cent. moisture and in the drier and more arid sections, such as the states along the Mexican border, will possibly retain only 5 or 6 per cent. on the average.

If a propeller is constructed under certain conditions and shipped to localities which are drier or damper it will absorb more or less moisture according to the atmospheric conditions, unless it is protected by some sort of a coating. As a result of the absorption or loss of moisture, the propeller will lose its balance and the wood will shrink or swell and otherwise distort the blade.

To gain the maximum speed and efficiency from a propeller, it should be entirely free from any tendency to vibrate. Vibrations may be caused by an unbalanced or distorted blade and many propellers are rejected by pilots for these reasons. This condition was forcibly brought out during the Mexican campaign a few years ago, when many propellers were lost because they were used under different conditions from those surrounding their manufacture. It was realized that the same thing might occur in shipping propellers from the United States to Europe where the prevailing moisture conditions are 3 to 5 per cent. higher than in localities in the United States.


United States Department of Agriculture
Forest Service
Forest Products Laboratory
Madison, Wis.
Comparative Effectiveness of Different Coatings in Moisture Proofing Wood When Exposed to a 95-100% Humidity
No. | No. of Specimens Arranged | Treatment
A | 11 | None — Natural Yellow Birch
B | 2 | 5 Coats Linseed Oil + 2 Coats Floor Wax
C | 76 | Filler + 3 Coats Spar Varnish
D | 2 | Filler + 3 Coats Orange Shellac
E | 67 | Filler + 2 Coats Enamel + 1 Coat Spar Varnish
F | 2 | Filler + 3 Coats Rubbing Varnish
G | 4 | 2 Coats Shellac + 1 Coat Spar Varnish + Aluminum Leaf + 2 Coats Shellac + 1 Coat Spar Varnish
H | 4 | 1 Coat Spar Varnish + 1 Coat Spar Varnish (size) + Aluminum Leaf + 2 Coats Spar Varnish
Absorption of Moisture in Grams per Square Foot of Surface in 17 Days
Max. Ave. Min.
A B C D E F G H

Comparative results of various tests for effectiveness of moisture-proof coatings

To overcome troubles due to moisture changes, it was necessary to use woods comparatively little affected by such changes. It so happens that woods of this class, such as mahogany and walnut, are relatively expensive.

A moisture-proof coating for propellers, therefore, is exceedingly desirable, (1) to produce a propeller unaffected by moisture changes, and (2) to utilize cheaper and more abundant woods such as gum, red oak and other common native hardwoods.

EXPERIMENTAL MOISTURE-PROOFING WORK.

In the effort to develop a moisture-proof coating, an extensive series of tests was planned, including tests of many different types of coatings, such as spirit, oil, and cellulose varnishes, enamels, linseed oil and wax treatments, impregnation treatments, and sprayed and electroplated metal. None of these coatings proved to be entirely satisfactory. Defects appeared in all of them, caused by lack of adhesion or inadequate resistance to the transmission of moisture. As a result of the above-mentioned work, however, an exceedingly effective, inexpensive, and easily applied coating was developed. The chief feature of this coating is a layer of aluminum leaf, which is incorporated between coats of varnish.

The diagram presents the comparative results of a number of tests on the effectiveness of various coatings. This diagram also shows clearly the progress that was made in this study to improve the coatings. At our entrance into the European war the first specifications issued called for the finish shown at "B" in diagram 1, which it will be seen is little better than no treatment at all. The results plotted at "G" and "H" in diagram 1 show the effectiveness of the aluminum leaf coating which was just coming into use at the close of hostilities.

Aluminum leaf coating has been tested in service in the United States and in overseas shipments, and found to be exceedingly effective. It will resist abrasion under service conditions as well as ordinary varnish coating, but is especially valuable for protection during periods of shipment and storage so that the propeller will be perfect when placed on the machine. Repairs are readily made if abrasions do occur.

The test used in these experiments was designed to approach service conditions. It was somewhat more severe than any tests which are likely to be met in service; that is, the normal or average moisture content for wood in France is about 15 per cent. while the condition under which the test was made would produce a moisture content in wood of from 22 to 25 per cent. The test consisted in applying the coating or treatment to a panel of yellow birch 5/8 inch by 4 inches by 8 inches. All surfaces were carefully coated and the specimens were hung in a compartment maintained at a relative humidity of 95 to 100 per cent. The weights of the panels were taken at regular intervals, the gain in weight in grams per square foot being used as a measure of the absorption or the amount of moisture transmitted through the coating.

METHOD OF APPLYING ALUMINUM LEAF.

Since the purpose of this coating is to moisture-proof wood thoroughly, it should be carefully applied. The leaf used is exceedingly thin and light; there are probably 12,000 to 15,000 leaves per inch, which makes it appear difficult to handle. If the suggestions outlined below are carefully followed, however, the leaf may be easily applied. While this article takes up specifically the process of coating propellers, the same procedure could be followed for coating other products.

Careful sanding to remove all tool marks and other imperfections is required in order to insure a perfectly smooth surface over which to apply the coating.

For open grained woods, a coat of filler consisting of 83 per cent. liquid and 17 per cent. silex should be used. The liquid should consist of 77 per cent. airplane spar varnish and 23 per cent. turpentine. The silex must pass a 200-mesh sieve. After the filler is applied to the wood and allowed to flatten, it should be rubbed off across the grain so as to fill the pores thoroughly. It should then dry for at least 24 hours, and afterwards should be sanded lightly.

The shellac varnish should consist of 4½ pounds of orange shellac gum cut in 1 gallon of clean, neutral, denatured alcohol. This should be applied evenly over the surface of the propeller, allowed to dry 3 or 4 hours, and then sanded lightly.

The size should consist of 75 per cent. airplane spar varnish and 25 per. cent. turpentine. It is suggested that a small amount of Prussian blue in Japan be added to the varnish to give it a color, so that spots subsequently left uncovered by the leaf will be readily visible.

The size should be brushed evenly over the surface as sparingly as possible, and allowed to dry until a tack is reached. This will permit the handling of the propeller immediately after the application of the leaf without disturbing the coating. The time will vary

Fig. 1.—Method used in turning pages of aluminum-leaf book

Fig. 2.—Transferring the book from left hand to right

Fig. 3.—Method of holding book when applying leaf

Fig. 4.—First operation in laying leaf

Fig. 5.—Second operation in laying leaf

Fig. 6.—Smoothing off the laid leaf

with the varnish and the weather. The varnish should dry for about 1-½ hour on a light dry day or in a heated building in the winter time, but a longer time may be required on a cloudy or damp day. This is an exceedingly important point and should be carefully considered since the coating hardens very slowly after the leaf is applied.

In applying the size, care should be exercised not to produce fatty edges or runs. If they occur, the leaf will be easily rubbed from the surface in handling the blade. For convenience in applying the leaf later, it is best to size one side of the blade at a time.

HANDLING ALUMINUM LEAF.

As soon as the size has reached the right tack, the leaf should be applied very rapidly over the surface. After the sized surface has been entirely covered, the leaf should be patted down with the palm of the hand or with a pad of cotton, and the rough edges should then be rubbed away. (See Fig. 6.) Any points not covered with leaf should be coated by applying a small piece of leaf to the spot with the fingers. The coating should be rubbed well with a piece of cotton which has been dipped in aluminum powder. This will insure the leaf sticking securely over the entire surface, and will fill any small holes not already filled.

Aluminum leaf comes in packs containing 500 leaves The pack is divided up into 10 or 20 books containing 50 or 25 leaves, respectively. The metal leaf is placed between the pages of these books and is in 4-inch, 4½-inch, 5-inch, or 5½-inch squares.

It is best to apply the leaf directly from the book by turning back the first page half way and holding it (Fig. 3) between the first and second fingers of the right hand. The book itself should be held between the thumb and fingers and in such a way that the back of the hand will be toward the work when the leaf is applied, the book being given a slight bend to prevent the corners of the leaf from drooping. The end of the leaf exposed by turning back the first page of the book should be placed against the surface to be coated (Fig. 4) and held securely in place by the left hand. The sheet held between the first and second fingers should be drawn back (Fig. 5) so as to allow the whole leaf to come in contact with the surface. The next sheet should be applied in a like manner, lapping edges with the first, and so on. The best results will be obtained if the gilder works in the same direction with each row of leaf; that is, from left to right. If this is done, it will aid considerably in completing and smoothing off the surface. Fig. 9 shows two propellers completely coated with the leaf.

It is suggested that in turning the pages of the book (Fig. 1) the back be held between the first two fingers of the left hand. The leaves from which the leaf has been removed should be turned back and held between the thumb and first finger of the left hand. The next sheet of paper may then be turned back, exposing one-half of the next leaf. The operation of changing the book from left to right hand is shown in Fig. 2.

LARGE HUB HOLE.

The large hub hole should receive the same treatment as the rest of the propeller. In applying the leaf to the hub hole, it is convenient to cut the books of leaf up into about 1-inch strips of leaf and paper, drop the strips (Fig. 7) vertically into the opening, and bring them into contact with the size. After the entire surface of the hole has been covered, it should be patted into place (Fig. 8) with a wad of cotton attached to the end of a stick.

SMALL HUB HOLES.

These holes should be corked up with ordinary corks, the tops of which should be cut off flush with the surface of the propeller and covered with the regular finish.

SHELLAC COLOR VARNISH.

After the application of the leaf, two coats of a shellac color varnish should be applied. This varnish should be made as described under the heading "Shellac Varnish Undercoating," except that enough color should be added to produce the desired shade. Four or five per cent. bismark brown in the shellac varnish will produce a desirable mahogany color. The amount of this material needed to get the best results should be determined by trial. The varnish should dry three or four hours before rubbing or recoating.

Each coat of shellac should be rubbed down lightly between coats without the use of oil.

FINISHING VARNISH.

A final flowing coat of airplane spar varnish should be applied and allowed to dry about 48 hours. This coating should not be rubbed or sanded.

ESTIMATED TIME REQUIRED TO COAT A PROPELLER.

The time required to apply the leaf to a propeller should not be more than 40 or 50 minutes. This could be reduced after the finisher becomes more experienced. The estimated time for applying the complete finish described would be in the neighborhood of 8 or 10 hours, and the entire total time needed for drying the various coats about 90 hours. The total time required for all operations would probably be in the neighborhood of 100 hours.

MODIFICATIONS OF ALUMINUM LEAF SPIRIT VARNISH PROCESS.

It might be desirable in some cases to use oil varnishes or enamels in lieu of the shellac described above. This may be done and satisfactory results obtained. If oil varnishes are substituted, a more durable coating may possibly be obtained, but it requires a much longer time to apply the finish because of the slowness with which oil varnishes dry. Each coat of varnish should dry at least 72 hours before recoating.

ACKNOWLEDGMENT.

Acknowledgment is made of valuable suggestions and co-operation extended the Forest Products Laboratory by the Airplane Engineering Department, Bureau of Aircraft Production, United States Army, at McCook Field, Dayton, Ohio, and by Mr. D. A. Kohr of Lowe Bros., Dayton, Ohio, in carrying out this work.

The Magnetic Field of the Sun

THE deduction from the electromagnetic theory of light made theoretically by H. A. Lorentz and verified experimentally by P. Zeeman, that by passing a beam of light through a magnetic field each spectral component is broken up into several components which are polarized, the number and polarization of the components depending upon the direction in which the light passes relatively to the direction of the lines of magnetic force, was applied several years ago to the investigation of the general magnetic field of the sun at the Mount Wilson Observatory. The results obtained were given in the *Astrophysical Journal*, 27, 1913. Using a polarizing apparatus with the 75-foot spectrograph of the large 150-ft. tower telescope, it was found that four lines in the third order specimen of a Michelson grating gave Zeeman displacements which agreed in sign and closely in magnitude with the theoretical values that would be deduced on the supposition that the sun was a uniformly magnetised sphere, the magnetic poles of the sun being at or near the poles of rotation. The approximate vertical intensity of the sun's general field at the poles was found to be about 50 gausses. Evidence was also obtained that the general magnetic field decreased rapidly in intensity in the upper levels of the solar atmosphere. It was a remarkable piece of work which enabled such conclusions to be put forward with confidence, based upon what at first sight appeared slender evidence, the displacements obtained being very small and not exceeding 0.001 Angstrom unit in amount. Further results since obtained have, however, confirmed the earlier conclusions; they are given in a paper by G. E. Hale, F. H. Seares, A. van Maanen and F. Ellerman in the *Astroph. Journ.* 206, 1918. In this paper, measures of displacements are given for 26 lines in the solar spectrum belonging to iron, chromium, nickel, vanadium, and titanium. Eighteen other lines, which had previously been found susceptible to the influence of the magnetic field in sun-spots, showed no measurable shift. The explanation of this is not clear. Using the laboratory data for the separation of these lines by a magnetic field of known strength, the field-strengths producing the observed separations were calculated and it was found that the field-strength decreased with increasing line-intensity. The strongest lines are those which originate in the upper levels of the solar atmosphere, and therefore this result is interpreted as indicating a field-strength diminishing rapidly with increasing elevation. Using Mitchell's results for the depths at which the chromospheric lines originate, it is concluded that the part of the field accessible to observation lies within the bounding surfaces of a thin shell in the solar atmosphere about 150 km. thick, and that definite values of the calculated field-strength always correspond to definite levels in the solar atmosphere.

The general nature of the sun's magnetic field may now be said to be known with some certainty, but the underlying causes of it remain obscure. The hypothesis that it is due to local whirls is examined, but the evidence on the whole seems to be against it.—*Science Progress.*

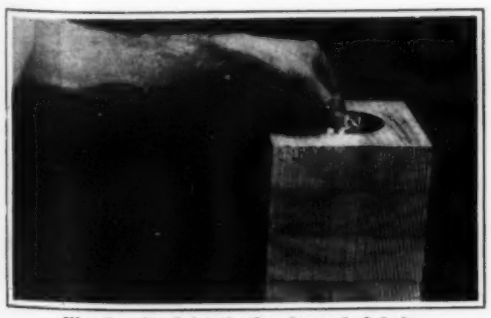


Fig. 7.—Applying leaf to large hub hole

Fig. 8.—Smoothing off leaf in hub hole

Fig. 9.—Two propellers completely leaf-coated

Changes of Ocean Level*

The Isostatic Subsidence of Volcanic Islands

By W. M. Davis, Harvard University

OBJECTION has sometimes been made to Darwin's theory of upgrowing coral reefs on subsiding foundations on the ground that the subsidence of the reef foundations should lower the ocean surface and lay bare a belt of recent marine deposits of smooth surface and simple shore line around the continental masses, while as a matter of fact the shore lines of continents are usually more or less embayed, as if the sea had recently advanced upon the unevenly eroded surface of the continental margins. The objection will, however, be found to have small weight when it is seen to rest upon the implied postulate that the embayments of continental coasts have as a rule been produced by a universal rise of the ocean surface, everywhere of the same amount and date, whereas their embayments testify to no such simple origin; and to proceed upon the unwarranted assumption that the subsidence of reef foundations requires the subsidence of broad areas of the ocean floors, whereas the local subsidence of the foundations themselves is all that is necessary.

The embayment of continental coasts is certainly of widespread occurrence, but when the embayments are closely examined they are found to be of dates and dimensions so diverse that they cannot be explained by a universal rise of the ocean. In the first place, the most pronounced embayments are the fiord coasts of quaternary glaciation; there is good reason to believe that the great troughs of such coasts were scoured out deep below sea level by huge glaciers, and that, far from the ocean having recently risen to submerge the troughs, the coasts have in several fiord regions risen from the ocean, as their elevated shore lines testify; these coasts are embayed in spite of recent emergence.

Furthermore, the supposition that coastal embayments result from a rise of the ocean around still-standing continental borders carries with it the implication that the coastal valleys, now submerged and embayed, were everywhere eroded during the same period of previous emergence, and hence that they should all be eroded to the same depth, and that their width should be proportionate to the weakness of the rocks in which they were carved during the emergence period. But as a matter of fact, the coastal embayments of the continents occupy valleys of depths and widths so various that they cannot be accounted for by these simple conditions; the diversity of the embayments demands many local and diverse movements of continental borders, even though a universal rise of ocean level has recently taken place, such as that which the final climatic changes at the close of the Glacial period should produce. The chief effect of such a rise of ocean level would only be to bring about a slight preponderance of embayed coasts along continental borders which had suffered local uplifts and depressions in about equal proportions.

Diverse movements of continental borders are demanded not only by the diversity of their embayments, but also by the not rare occurrence of emerged coastal plains of marine sediments. Thus the western side of the Adriatic is bordered by an emerged and more or less dissected coastal plain, while the eastern side is bordered by a partly submerged and elaborately embayed mountain border. Greece and the Bosphorus bear marks of recent submergence, but the coast of Palestine appears to bear marks of recent emergence. The small embayments of the Texas coastal plain cannot be explained as resulting from the same amount of submergence which produced the deep rias in the mountainous coast of northwestern Spain; nor can the unlike valleys of those two coasts have been eroded during the same antecedent period of emergence. The elevated shore lines of the California coast have no equivalent on the volcanic islands of the Pacific. The recent submergence of the northeastern coast of New Caledonia following a long-enduring emergence, as indicated by the deep embayments of its strongly cliff shores, demands a different succession of changes of level from those recorded in Peru or Virginia.

The postulate that the embayed coasts of the world demand a universal rise of the ocean for their explanation is largely based upon the indoor study of coastal charts, and not upon the field study of the coasts themselves; and inasmuch as most of the coastal charts of the world have been made by hydrographers, who concerned themselves little with the physiographic history of the coastal slope, such charts cannot be relied upon to present all the information that is pertinent to the problem under discussion.

It occasionally happens, however, that a hydrographic chart presents evidence which suffices to correct a false inference regarding recent submergence; thus one of the Solomon islands, which has a well-embayed shore line, is fronted for many miles by an elevated off-shore barrier reef, even crested and 80 or 100 feet in height; hence although the coastal embayments show that submergence has taken place, the reef shows that the last change of level was an emergence, less in amount than the previous submergence.

In view of these examples it is evident that the chart of an embayed coast, outside of the coral zone and not yet examined geologically, cannot be trusted as indicating that the last change of ocean level was upward. Therefore the inference that there has been a general rise of ocean level, independent of oscillations during the Glacial period, is not at present well supported; and until it is well supported, a certain amount of broad ocean-floor subsidence in the coral seas, as inferred by Darwin from this theory of coral reefs, may be regarded as not impossible, particularly as its effect in lowering the ocean may have been counteracted by equally broad ocean-floor uplifts in other regions.

Nevertheless, it is somewhat arbitrary to assume that the broad areas of ocean-floor subsidence should occur chiefly in the warmer zone, where coral reefs could be formed, and that the areas of compensating uplift should be chiefly in the cooler oceans, or in those parts of the warmer oceans where no islands rise. Hence the supposition of local subsidence of volcanic islands, which usually serve as reef foundations, deserves consideration as an alternative to broad ocean-floor subsidence. This supposition would be objected to by scientists of the older school, who believed that volcanoes occupy areas of elevation. Thus Guppy said: "In establishing the fact of the presence of active volcanoes in regions of barrier reefs and atolls, I shall be removing one of the principal standpoints of the theory of subsidence;" he added that this "places the supporters of the theory of subsidence in a dilemna."[1] At about the same time Hickson wrote: "I am persuaded that . . . the presence of such an atoll as Passiac [in North Celebes] so close to a region of quite recent and considerable volcanic activity is difficult to account for under this [subsidence] theory."[2] Murray went so fas as to object to Darwin's theory of subsidence on the ground that even extinct volcanoes are not likely to subside. He wrote: "Generally speaking, all the volcanic regions which we know have in the main been areas of elevation, and we would expect the same to hold good in those vast and permanent hollows of the earth which are occupied by the waters of the ocean. . . . Areas of local depression are to be looked for in the ocean basins on either side of and between groups of volcanic islands and atolls, and not on the very site of these islands."[3]

Much may be said against this obsolescent view, and in favor of the opposite view that volcanic action and subsidence may sometimes be closely associated. Strong testimony to this effect is offered by the repeated occurrence of volcanic eruptions in areas of subsidence during the geological evolution of Great Britain, as worked out by an exceptionally competent geologist whose conclusion is: "The study of the records of volcanic action in Britain proves beyond dispute that the volcanoes of past time have been active in areas of the earth's surface that were sinking and not rising. . . . I do not wish to maintain that the downward movement was necessarily a consequence of volcanic ejections. . . . but I have sometimes asked myself whether it was not possibly increased as a sequel to vigorous action."[4] An interesting piece of evidence concerning the subsidence of the great volcanic island of Hawaii during the later stages of its eruptive growth is furnished by Branner, who gives good reason for thinking that the deep canyons in the northeastern sector of the island have been eroded in part of an older, deeply dissected, and now partly submerged volcanic mass, the remainder of which has been overwhelmed and buried under more recent lava floods.[5]

The newest discussion of this problem is by Molengraaf, who calls attention to the results of recent gravity determinations, from which it appears that the volcanic islands of the Pacific "as far as they have been studied are not isostatically compensated, and, without exception, show a larger or smaller positive anomaly of gravity. . . . These volcanic islands, rising . . . as cones or groups of cones of considerable bulk, cannot always remain in existence; under the influence of gravity they will without exception yield and sink down slowly. . . . The yielding and slow sinking of the volcanic islands under the influence of gravity must be regarded as the cause of the downward movement of large amount and long duration which must be assumed in order to explain the formation of barrier-reefs and atolls in true oceanic regions."[6]

This appears to me an important suggestion, and one that is likely to remove the objections to Darwin's theory of coral reefs in so far as they are directed against a great subsidence of broad ocean-floor areas; for although Darwin himself was led by his coral-reef theory to infer the subsidence of such areas, it is clear from the original exposition of his theory that local subsidence of reef foundations will serve all its needs. It may be added that the accumulation of the great limestone masses of atolls upon slowly sinking volcanic foundations must aid and prolong their sinking; also that no comparable sinking of volcanic cones upon continents need be expected, not only because of the differences supposed to exist between the earth's crust in continental and oceanic areas, to which Molengraaf calls attention, but also because continental volcanoes suffer erosion, whereby their waste is carried away and widely distributed, while oceanic volcanoes retain the waste from their summits on their flanks.

But it is particularly the relation of Molengraaf's hypothesis to changes of ocean level that I desire to emphasize. Let it be imagined that the ocean floor suffers no deformation apart from that associated with volcanic action, and that a thousand great volcanic cones are built up from it in the coral zone, one after the other and at such intervals of time that their formation stretches through the Tertiary and Posttertiary periods. The building of the first cone would cause a slight rise of ocean level. As the cone slowly subsided the ocean surface would return to its normal stand, were it not that the subsiding cone is reconstituted in an atoll as fast as it subsides,[7] and that other cones are built up as the first one sinks. Later formed cones would prolong the changes thus initiated, and the slow rise of the ocean would continue, particularly if the isostatic sinking of some of the cones were incompletely accomplished. Even if some of the cones sank so fast that reef-making corals could not reconstitute them, the net result of this process, after many cones had been built up and sunk again, would be, not a lowering of the ocean surface such as according to the usual interpretation of the theory of subsidence has been supposed to accompany the upgrowth of coral reefs, but a slow and long continued rise of the ocean surface.

The rise of the ocean surface thus caused would be much less in total amount than the sinking suffered by any one of the volcanic reef foundations, and hence less than the inferred great thickness of many atoll masses, but it would presumably be sufficient to cause a moderate preponderance of submergence on continental coasts which themselves suffer many diverse movements of upheaval and depression. It is not, however, to be supposed that general warpings and deformations of the ocean floor, upward and downward, should be left out of consideration; such movements have surely taken place to a less or greater degree, particularly in the western Pacific, where coral reefs border continental islands. The integrated effect of all these causes of change in the level of the ocean surface cannot now be determined, because so little is known regarding the various factors of the problem; but nothing in the little that is known and in the much more that may be fairly inferred should be regarded as discountenancing the theory of upgrowing reefs on subsiding foundations, essentially as Darwin supposed. His primary theory of coral reefs holds good, although his supplementary theory of broad ocean-floor subsidence needs modification.

* From the *Proceedings of the National Academy of Sciences.*

[1] Guppy, H. B., *Scot. Geogr. Mag.*, 14, 1888, (121-137); see p. 135, 136.

[2] Hickson, S. J., *A naturalist in Celebes*, London, 1889; see p. 42.

[3] Murray, J., *Proc. Roy. Soc. Edinb.*, 10, 1880, (505-518); see p. 516.

[4] Geikie, Sir A., *The ancient volcanoes of Great Britain*, London, 1897; see vol. 2, p. 470.

[5] Branner, J. C., *Amer. J. Sci.*, 16, 1903, (301-316); see p. 301-303.

[6] Molengraaf, G. A. F., *Proc. k. Akad. Wet. Amsterdam*, 19, 1916, (610-627); see p. 619-620.

[7] This statement depends on the fact, certified by chemists, that the withdrawal of limestone from solutions in water diminishes the water volume by only a small portion of the volume of the withdrawn limestone.

The Cedars of Lebanon*

References to the Trees of Great Age That Form the Nucleus of the Historic Grove

By Prof. A. Henry, M. A., F.L.S., Royal College of Sciences for Ireland

SIR MARTIN CONWAY, in his letter of October 9th, throws doubt on the claim of great age for some of the cedars still existing on Mount Lebanon. It will be interesting to approach the problem of the age of those trees in two ways, one historical, the other based on actual count of the annual rings that are visible in sections of their stems. In the first place, there is historical evidence to prove that the grove of cedars, which is near the village of Bsherreh, has been celebrated for centuries. This grove, which belongs to the Maronite patriarch, consists now of a few giant trees, and of a considerable number of smaller trees, evidently of a much later generation. Belon, a French traveller, who visited Mount Lebanon in 1550, states that the old trees were twenty-eight in number; and "these the Archbishop of Damascus has endeavored to prove to be the same that Solomon planted with his own hands in the quincunx manner, as they now stand." In the course of the 350 years that have elapsed since Belon's visit, the number of the larger trees, to which great age was attributed by tradition, has gradually become lesser and lesser; and the slowness of their decay and disappearance confirms the belief that they were already of great age in 1550. They were, in fact, a sacred grove, probably dating from ancient times, as at that date, under their shade on the eve of the Transfiguration of our Savior, the Maronite fathers and numerous pilgrims spent the night in dancing a kind of Pyrrhic dance, in singing and in feasting; and on the following day the patriarch celebrated high mass on an altar built under one of the largest and oldest cedars. This festival was called "The Feast of Cedars." The fact that the grove was sacred no doubt accounts in part for the preservation of the old trees through centuries. In Beldon's time the Maronite patriarch threatened with excommunication anyone who would injure the cedars. Those which were blown down or fell from decay were utilised by the monks of the neighborhood.

Rauwolf, the next traveller to visit the grove, in 1574, saw twenty-six great cedars "with strong stems that were several fathoms about." Thévenot made the number of the old cedars to be twenty-three in 1653. Maundrell, in his "Journey from Aleppo to Jerusalem" in 1696, says: "These noble trees grow among the snow, near the highest part of Libanus. Here are some very old and of a prodigious bulk; and others younger, of a smaller size. Of the former I could reckon up only sixteen; the latter are very numerous. I measured one of the largest and found it 12 yards 6 inches (36½ feet) in girt, and yet sound." Dr. Pococke, who visited the Lebanon in 1744, found fifteen large trees standing, and one that had been blown down by the wind. The tree with the roundest stem, though not the largest, measured 24 feet in girth; and another, with a triple stem, was triangular in section and measured 12 feet on each side. The festival was celebrated in Dr. Pococke's time. I shall omit the accounts of other travellers, as these may be seen in Loudon's "Arboretum," Vol. IV, p. 2410, and quote M. Laure, who visited the grove in 1836: "Fifteen of the sixteen old trees mentioned by Maundrell are still alive, but are all more or less in a state of decay. One of them is remarkable for three immense trunks. Another, one of the healthiest of the old trees, though perhaps the smallest, measured 33 feet French (35 feet 9 inches English) in circumference."

Sir Joseph Hooker carefully examined the Lebanon grove of cedars in 1860, which then comprised 398 trees, scattered over three or four acres in nine clumps. Of these, there were fifteen trees much larger than the others; and their size and proximity to the Maronite chapel indicated that they were the survivors of the twenty-eight old cedars described by Belon in 1550. During the intervening 310 years we have the testimony of successive travellers to the gradual disappearance of thirteen of the original number. The fifteen large cedars were measured by Hooker as follows: two, each with a trunk 13 ft. in diameter; one each of 12 ft., 11 ft., 10 ft., 9 ft., 8 ft., and 6 ft. diameter; two, each of 7 ft. and five each of 5 ft. diameter.

M. Gadeau de Kerville, the author of a remarkable book concerning the old trees of Normandy, and therefore a competent observer, visited Lebanon in 1908, and says: "The very large cedars, unhappily in a state of decay, are far from having the enormous dimensions attributed to them by certain authors. Some specimens are indeed immense, but these have diverging branches coming off the trunk at a very low point, so that the measurement taken at 3 ft. above the ground is not the real girth of the stem, but the circumference of the stem and branches. Such measurements are inaccurate, and do not give a true idea of the real size of the trunk." M. Gadeau de Kerville measured the four largest cedars in the grove, which had trunks free of branches near the base, and found their girths, taken at 3 ft. 3 in. above the ground, to be 22 ft. 7 in., 21 ft. 7 in., 21 ft. 1 in. and 18 ft. 4 in., which correspond to diameters of 7 ft. 2 in., 6 ft. 10 in., 6 ft. 8 in. and 5 ft. 10 in.

It is difficult to reconcile this recent account of the cedars on Lebanon with that given by Hooker in 1860, unless some of the largest trees have disappeared meanwhile. It is unfortunate, however, that M. Gadeau de Kerville, not having access to Hooker's measurements, was unable to trace the different large trees measured in 1860, and unluckily did not measure, even at ground level, the cedars that he admits to be enormous, but branching at the base.

With regard to the age of the old cedars, Hooker attempted an estimate as follows: He counted 140 annual rings on a section 8 in. in diameter, that was cut off a branch from near the base of an old tree. On this basis, viz., 210 rings to a foot of diameter, he considered that the largest tree, 13 ft. in diameter, might be 2,500 years old. It is evident, however, that the growth of such a branch must differ considerably from that of a stem; and his estimate of the age of the cedars was "no doubt widely far from the mark."

In the Timber Museum at Kew there is a section of cedar brought home from the Lebanon by Mr. Cyril C. Graham. This section, cut from a stem at some height above the ground, accords a fair criterion of the rate of growth of this species on Mount Lebanon during the early part of the life of the tree. This section is 20 in. to 23 in. in diameter, and shows about 235 annual rings, their width varying more or less with the age at which the rings were formed. The annual rings near the centre, formed when the tree was young, are about 1-10 in. wide; while those in the outer part of the heartwood, formed when the tree was 160 years old, are much narrower, being scarcely 1-60 in. Their average width over the whole section is 1-20 in. As a rule, the older a tree is, the narrower is the annual ring. This rule is borne out by the elaborate investigations which have been made by Professor Huntington on the growth of the giant sequoias in California. These trees up to 350 years old form annual rings averaging 1-10 in. to 1-12 in. in width; between 350 and 750 years, 1-16 in. to 1-25 in.; between 750 and 1,450 years, 1-25 in to 1-30 in.; after which they diminish very slowly, being 1-36 in. at 2,500 years old.

Assuming that the cedars on Lebanon attain, like the specimen brought home by Mr. Graham, 2 ft. in diameter at about 250 years old, and that they afterwards grow at the rate of 1-30 in. in width per annum, a tree 8 ft. in diameter would be 1,330 years old; and one 13 ft. in diameter, about 2,230 years old. The tree 8 ft. in diameter has a radius of 4 ft., of which the innermost foot is made up of 250 rings; and the outer 3 ft., as there are supposed to be 30 rings in each inch, of $36 \times 30 = 1{,}080$ rings, making 1,330 rings in all. By a similar calculation we obtain 2,230 years for the tree of 13 ft. diameter or 6½ ft. radius. If the trees, however, grew at a slower rate, as is possible, their age might be even greater.

As a check on the dimensions of Mr. Graham's Lebanon specimen, I may mention that in the forest of Belezma in Algeria,, which I visited in 1907, cedars 255 years old averaged 4 ft. 3 in. in diameter, about double the rate of growth on Lebanon, which is explained by the superior conditions of soil and climate in the Algerian forest. The extremely slow growth of the cedars in the isolated grove on Mount Lebanon is due to the very poor calcareous soil in which they stand, and to the high altitude—over 6,000 ft.—which makes the growing season extremely brief, the snows rarely quitting the basin of the cedars before the end of July or the beginning of August.

Cedars growing in England in good soil at elevations little above sea-level, and enjoying our moist, genial climate and a long growing season, make very wide rings annually, and speedily attain great dimensions. This is well illustrated by contrasting the cedar (see Elwes and Henry, "Trees of Great Britain," Vol. III., page 459) cut down in 1874 at Wilton House, Salisbury, which had attained 11 ft. 9 in. in diameter at 236 years old, with the specimen from the grove on Lebanon of exactly the same age which only made 1 ft. 10 in. in diameter. Of the grand old cedars still flourishing at Wilton House concerning which Mr. W. Gardiner gave some interesting details in a published letter, the largest measured by Mr. Elwes in 1903 was 21 ft. in girth and may not be of the same age as the veteran that was felled in 1874. There is a considerable confusion in the traditional records of the early planting of cedars in England due to the fact that both Dr. Edward Pococke, chaplain at Aleppo in 1629, and at Constantinople in subsequent years, and Dr. Richard Pococke, who travelled in the East during 1737 to 1742, brought home seed of the Lebanon cedar. There appears to be no reason to doubt that the remarkable old cedar at Childrey Rectory near Wantage, the history of which was given by Mr. C. J. Cornish in *Country Life*, May 2nd, 1903, was planted by Dr. Edward Pococke, who, after his return from Constantinople, was appointed to the living of Childrey in 1642. At Kew the growth is very fast, as a section of one cut down there, which is preserved in the museum, shows 113 annual rings and is 4 ft. 5 in. in diameter. Some of the rings on this section are ⅜-in. in width.

The following description of the famous grove, written by Commander Mansell, R.N., in 1861, gives a good picture of the scene:

"The first appearance of the cedars is grand in the extreme. No other tree is visible near them. They stand in noble solitude, a dark speck in the centre of a great basin, whose sides rise steep and precipitous to a height between 2,000 ft. and 3,000 ft. The position of the grove is very remarkable. It forms the centre of the basin, with a plateau below, cultivated with corn, and another above, between it and the great ridge.

"The moraines or hillocks, seven in number, on which the cedars stand, appear to have been formed by *débris* and immense boulders from the adjacent edges of Mount Lebanon, brought down by avalanches or broken off by storm and tempest. These ridges form a perfect basin, barren and devoid of all verdure, save the prickly astragalus bush, which attains a considerable size and exudes gum during summer.

"The space occupied by the trees, 389 in number, is small, forming seven mounds on the south side of a watercourse (now dry). Fifteen scattered trees of considerable size have sprung up on the northern ridge; they appear more stunted and broken than the others.

"Each winter great branches are broken off the older trees by the snows. The trunks or main stems of these trees appear in most instances compact and solid; and if we may judge from one which was lying prostrate, having been blown down two years since, and which was being sawn into planks by the monks of an adjacent monastery, are still in a state of good preservation, close-grained, very sound, and of a light straw color.

"On the highest and most central mound a small chapel has been built; and at certain seasons the peasants resort here, Mass is celebrated, children are christened, and marriages take place. On these occasions at night the grove is lighted up with numerous fires and lamps.

"During our stay we were fortunate to witness the Fête of the Transfiguration. The chapel mound is 238 ft. above the lower plateau; and on its western slope stand the two largest trees, measuring 46 ft. in circumference and apparently in a sound state. Near lies an immense boulder, measuring 20 ft. long, 14 ft. broad, and 6½ ft. thick. On this mound are 82 trees. These and the 77 trees on the mound immediately to the south seem of an earlier date than the others. One has been hollowed out, where a hermit is said to have lived many years. Occasionally young trees are found growing between the great branches of the older ones, where a soil composed of decayed cones and leaves furnishes sufficient nourishment for their support; but it is extremely rare to find any on the mounds. Whether it is the heat of the summer or the goats which destroy them before they attain any size, I could not discover. The names of many travellers who have visited the interesting spot are cut on the largest trees, and in some instances the bark, which is very thick, has grown over and partly obliterated them."

Sir Joseph Hooker's notes and exact measurements of the different trees are given in "Woods and Forests," May 7th, 1884, page 328, and should be consulted by any traveller proceeding to visit the grove on Mount Lebanon, as it would be very interesting to determine exactly how many of the very old trees still survive.

*From *Country Life*.

Three stages in the manufacture of flower models of blown glass

Flowers and Tiny Animals in Glass

A Little Known Branch of the Blower's Art Turned to Account by the Natural History Museums

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Glass blowing is an art which has been well pictured, and often described; but there are withal certain branches of it that have not been given their due share of attention in these presentations of the subject to the general public. It is rather with glass blowing as a science that the usual treatment deals; and though holding high rank as an industrial science, it is necessary to recognize it as an art also. Creative effects at which no painter or sculptor could afford to scoff are possible to the expert handler of forceps, carbon pencil and gas flame.

One extremely interesting by-path is the construction of glass models for museums. It is found that for the representation of simple and complex plant and animal forms nothing is superior to glass. Accordingly, at an institution like the American Museum of Natural History, we find an expert in this art continually at work.

The glass to be blown usually comes in the form of tubes of various sizes and colors, and from these can be made almost anything in the way of animal or vegetable. The American Museum already has a large and interesting collection of these beautiful models, and is constantly enlarging it, thanks to Mr. Herman Miller, samples of whose work and ways of working are illustrated on this page and on our cover.

The first step toward any model is always the heating of the tube of glass in the gas flame, preparatory to blowing it into the desired shape. In the photograph that illustrates this stage the gas flame is unfortunately concealed behind the operator's left hand; that there is really a source of heat there, however, is made manifest in the second view, showing what is done with the tube after it has become sufficiently softened. Every high school student, in the physics or chemistry laboratory, has heated a thin tube of glass until it was possible to draw it out into a thread and finally see it snap off; and that is what Mr. Miller is doing here. Only he stops before he reaches the breaking point, long enough to assure himself that he has drawn out his thread to just the right length and thickness. Then he breaks off the end of the tube—in the case shown, after it has assumed the form of a glass rod with a small tube on one end.

The next picture shows us clearly what it is that the operator is working toward. He has broken open one end of the rod, after softening it again in the flame, and now he holds the piece in the heat of the gas jet, while with a carbon pencil he models it gradually into the form of the petals. The carbon, of course, is not affected in any way by the degree of heat employed in this operation; and the glass can be worked by a skilled man into any shape whatever, and made to assume any form which he may have in mind.

But even with this operation he is not at the end of his resources. It is evident that if materials like steel and iron can be welded in a flame of sufficient heat so that two separate pieces flow together and become one, the same thing can be done with even more ease and much less heat in the case of glass. This simplifies the modeller's work; for a very difficult bit of modelling, such as would be required to form the stamens and other protruding parts of the flower, will be replaced by a comparatively simple job of welding. So we show the glass modeller adding little branches to the ends of his petals. He merely takes a small piece of glass and touches it to the main flower at the point where the latter is red hot from the flame. Then the joint is made, and the excrescence which has been added to the flower can be further modelled as may be desired. When colored spots or stripes are to be added to the main body of the flower, the colored glass is put on in this same way.

But flowers and such simple things are by no means the limit of the modeller's skill. In fact, his best and most instructive work lies in other fields. We are in the habit of speaking of the lower animals in terms of more or less contempt; but when we come to study their structure we find it sufficiently complex. When we magnify these tiny creatures, we find them to be of wonderfully complicated structure; and the manufacture of a glass model to represent one of them is no laughing matter. Our cover this week shows Mr. Miller assembling the parts of Trypanosphaera into a model which shall represent this little denizen of the deep with a magnification of 200 diameters. This one piece of work represents six weeks' labor of the most careful and painstaking kind. It is really impossible to appreciate from the photograph the thousands of delicate parts that go to make up this beautiful model. It appears to be a mass of transparent bubbles, one

Attaching projecting members to the model of a flower, and putting the spines on the glass stem of a marine plant

within the other, and yet all connected in a single group.

This is but one of a series of models intended to bring the members of the protozoa family, the one-celled animals, before our eyes. This group includes the most minute animals and the simplest forms of animal life; but it is obvious from the pictures that an animal may be simplest without being to any alarming extent simple. Especially does this remark apply to the radiolaria, protozoa which manufacture for themselves tiny domiciles of silicious material—really glass, just as much as is the material in which Mr. Miller preserves their forms for the human eye to contemplate. Some idea of what these creatures are capable of, and incidentally what the glass modeller is capable of, may be gleaned from our group picture showing models of four varieties as they appear when magnified from 100 to 500 times. The one at the extreme right will be recognized as our friend of the cover, Trypanosphaera. The others possess appellations of various degrees of unpronounceability.

Agricultural Possibilities of the Sahara

It is no secret that the airplane patrols of the French army in Northern Africa have had a salutary effect in preventing intrigues or uprisings among the natives occasioned by the machinations of German agents. It is planned, moreover, according to J. Nicholas Brusse in *Le Nation* (Paris), shortly to establish a postal service between Morocco Algiers and Tunis, and the French possessions further inland. Apropos of this the aforesaid maga ine is moved to review the possibilites of agricultural exploitation of the famous Desert of Sahara.

As far back as 1893 Henri Schirmer[1], whose ideas on the geography of the Sahara and its climate are today accepted by all the world, and no longer inspire criticism, proved that the Sahara is not entirely lacking in rain although the regimen of the winds occasions its present sterility; he has explained that the Sahara is not absolutely unfit for life, either for plant life or for animal life; but that Saharan agriculture has but little resemblance to that of other countries; that the European cannot suppress a desert as some of them dream of doing, and that a strategic road could be constructed across it as far as the Soudan, that its oases should be developed and "that land long left barren should be restored to cultivation." It is our purpose in this article to explain that recent explora'ions and economic studies may, perhaps, permit us to form a somewhat less conservative opinion as to what can be accomplished in the desert of Sahara. The surface of the Sahara is estimated at 2,394,200 square kilometers, and its population at 450,000 inhabitants[2]. It is incorrect to believe that this expanse is a recently emerged bottom of the ocean. The Sahara as a whole has an altitude of 450 meters. It consists of a vast series of plateaus with a few groups of mountains (Dr. L. Trabut and R. Mares).

The Sahara has been incorrectly represented as an immense expanse composed of shifting sands, receiving no rain whatever, and entirely destitute of vegetation. It is chiefly the lack of safety of the Sahara and of the Central Soudan, which have been the scourge of this region, where, alas, we have counted so many martyrs, as was said fifteen years ago by the late regretted Paul Leroy-Beaulieu.

The Sahara is, to be sure, a very dry region; *but it does rain there.* It also contains a number of wells or pools of water—without mentioning the numerous Ghedirs, "temporary ponds or water holes, spots where rain water stands for a certain length of time." (Mission Saharienne, Foureau-Lamy, 1898-1899)—but for many centuries these wells have received no attention and no care.

As soon as our men arrive at them it is found necessary to put them in order, as sometimes the Tuaregs fill them with sand level with the ground. Another legend which does injustice to the Sahara is, that this immense expanse is entirely deprived of vegetation: but the largest portion of this immense surface proclaimed as a desert in reality possesses a plant life which is quite various and often very abundant. It contains numerous *pastures* and some pieces of *woodland*, even outside the oases. These bits of woodland are, to be sure, rarer and more circumscribed than are the forage plantations, but they are not entirely absent. Besides the palm tree, which requires rather a large sheet of water, various other sorts of trees are found in the Sahara (aside from numerous shrubs and tamarisks); principally the rubber tree (*Talha, Acacia, Tortilisp*, and the ethel, a variety of the tamarisk (Mission Saharienne, Foureau-Lamy). In the Southern Sahara the Doumor Egyptian Palm is found; it does not bear fruit, but the trunk and branches serve various purposes. The Apir possesses other arborescent species—notably mimosas of all sorts; in the most unpromising regions, such as the Tassili, Foureau believes that wooded plateaus still exist.

The Sahara contains a number of forage plants and shrubs. It was upon these that the caravans pastured, and that even the twelve or thireen hundred camels of the Foureau-Lamy Expedition and its auxiliary convoys succeeded in sustaining themselves. Among these plants are: *Mrokba, Drinne* (the two best ones), *Abot, Necin, Had, Erg, Horta, Ghessal, Tarfa, Ana.* This last found especially in the Southern portion. The Drinn, a large grass, serves as food for camels. Its stalk is employed like alfalfa to manufacture ropes and twine, and the natives eat the seeds.

Besides these Ferand Foureau mentions the Djedare, the Foleziez, the Gouzzal, the Lemnad, the pink laurel, the Kornnika, the Adjac, etc. It must not be forgotten that we are speaking here of spontaneous vegetation. which grows without demanding help or labor from man. It is, therefore, an incontestable fact that these pasture lands are capable of a certain degree of improvement, provided there is an initial establishment of roads of communication. This improvement can be attained by the selection of the best grasses, forage plants, and arborescent species. According to MM. L. Trabut and R. Mares, the Saharan plants are very remarkable in their adaptation to a dry climate and a salty earth. The date tree is adapted to those Saharan regions which are well provided with water; beneath the date trees cultivation to kitchen gardens is very well developed. In the oases are found the fig tree, the apricot, the peach and the grape. Agriculture succeeds well in the oases of the north, as at Biskra. The cultivated cereals are barley, wheat, sorghum and millet or *penisillaria spicata;* lucerne is the forage plant of the oasis. It is of a very beautiful variety, with wide leaves, and seems very resistant to salt.

Industrial cultivation is confined to a few plants; *henn (Lawsonia Inermisp* [Madder] (Rubia or Asperule Tinctoriale) tobacco, (the yellow flowered variety of *nicotiana Rustica*) especially used for snuff. It has been found possible to make a very agreeable and aromatic brandy from dates.

As to the fauna, it is quite numerous and various: in the southern portion there is a great abundance of guinea fowl, and of domesticated humped cattle or zebus (*bibos Indicus*): in the north are gazelles, antelopes of all sorts, and camels, goats, sheep and asses everywhere. The sheep of the Sahara belong to the "Barbarine race"; further south this race is replaced by the Touareg sheep (*Ovis longipes*). The ass of Souf is remarkable for its size and strength. The vegetation of the *had* as soon as one penetrates into the erg is luxuriant; game also breeds abundantly (F. Foureau). In the South there are found, besides giraffes, ostriches, monkeys, jackals, hyenas and even lions. This varied flora and fauna implies that, even in the central Sahara, there are permanent populations destined to become denser with an increase of safety, of steady labor, of roads of communication and facilities of transport.

One must admit that these data are very encouraging. It should be added, moreover, that if some of the explorers who have made bold excursions into various countries of the Sahara region have met death by assassination, like Flatters and Lieutenant Pallat, on the other hand not a single one has been heard of who has either died of thirst, famine or maladies due to the climate, or who has been swallowed up by sand.

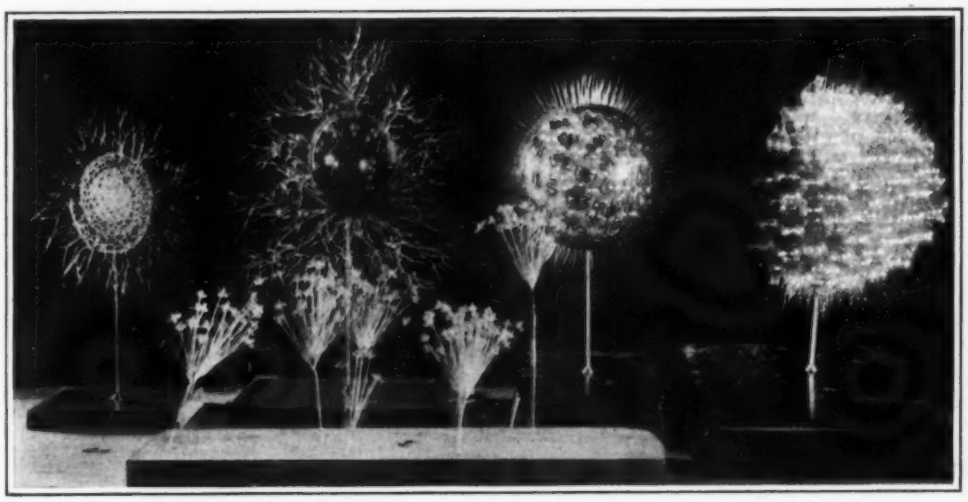
It has been chiefly the depressing anarchy and lack of safety which have prevented the Sahara from undergoing a useful development. This is an irrefutable fact; thus, for the most abandoned portions, M. Foureau, Captain Feirn and the geologists Ville (1855-1863), and Pomel (1862) have declared that oases could be either created or notably enlarged. It is probable, in fact, that as soon as all of the wells are put in proper condition, all the waters are cared for, and advantage taken of all the streams having a capricious or subterranean course, groups of population, no longer fearing spoliation of their property and the fruits of their labors by nomadic robbers, will settle in the most favorable places, and that they will be found in the heart of Tassili, as much if not more so than in such regions as that of Constantinois, whose settlement, moreover, was not definitely achieved until towards the end of 1899 by the possession of Tuat.

Did not Dr. Trebut and R. Mares inform us in 1906 that French companies of colonization had created important centers everywhere by means of digging wells?

So far as concerns the sub-soil, though not entirely lacking da.a, we are still obliged to have recourse to conjecture. Foureau made a statement in 1893 that there must be carboniferous deposits in the north; and declared that he had traversed much ferruginous territory. It cannot be doubted that so vast an area, a great part of which is not formed of sand, as is commonly believed, but of quartz and of granite, must contain much mineral wealth. Have we not seen the deserts of South America enriched by nitrates? In a work by M. Flomand, published at Algiers in 1897, he spoke of certain indications which inspire the hope of the discovery of deposits of nitrates in the Southern Oasis. Even in Algeria, in the Sou.h Constantinois, mineral research has been but little attempted, except in the territory of the Ain-Sofra, where there have been found in many places traces of copper, silver-bearing lead, galena, antimony, asbestos; but no deposits of any importance had been exploited as late as 1916. Rock salt exists throughout the South, especially in the territory of Ghardaia. According to the geologist Ville, the Zahrey contains 250,000,000 tons of it.

The springs of the "Rock of Salt" on the Djelfa route can furnish possibly 14,000 tons per year. The exploitation of the salt deposits in the territories of the South has heretofore been confined to the needs of the population of that region by reason of the high cost of transportation. The total mineral production does not exceed one million francs ($200,000). In short, the Sahara is of considerable value so far as its surface alone is concerned.

As a strategic route, entirely French, running towards the African countries whose future is rich in possibilities, it is of great importance to France. By creating highways of communication therein the Saharan question can be very profitably solved so far as regards agricultural and pastoral affairs. In this way the misunderstood Sahara can be rehabilitated, thanks particularly to the important efforts of M. F. Foureau, bu it will be necessary to interest the natives in this great work.



A series of models to illustrate the protozug family, or the so-called one-celled animals.

The group shows a model of each of the following forms taking them from left to right: 1. Tholspira magnified three hundred times. 2. Lithocircus magnified five hundred times. 3. Colozoum magnified one hundred times. 4. Trypanosphaera magnified two hundred times.

[1] La Sahara, octavo, 443 pages, six pistes. Paris, Hachette, 1896.
[2] Annuaire du Bureau des Longitudes for 1915.

Some Things That Might Be Used

A Survey of the Waste That Makes Woeful Want, Whether or No It Be Wilful

By John Waddell, Ph.D., D.Sc.

THE classical example of waste is, I suppose, that humorously depicted by Charles Lamb in his "Dissertation upon Roast Pig" where he tells how the stupid Bobo set fire to his father's house and burned a whole litter of sucking pigs. He and his father, Hoti, accidentally burning their fingers in the carcass of a pig, instinctively tried to cool them in their mouths and thus the deliciousness of roast pig was first discovered.

Thereafter, Hoti and Bobo had occasion frequently to burn down their dwelling and, the neighbors finding out their secret, conflagrations became so common "that the insurance offices one and all shut up shop. Later on a sage arose like our Locke, who made the discovery that the flesh of swine, or indeed of any other animal, might be cooked without the necessity of consuming a whole house to dress it." This waste thereupon ceased.

A story not so well known but probably more authentic is told by Liebig who visited a manufactory for the making of Prussian blue. He was taken by the proprietor into a room where he was almost deafened by the clang and clatter of large iron pestles grating and grinding in large iron mortars. When he suggested that less noise would be an advantage, he was told with an air of pride on the part of the manufacturer that the greater the noise the better the blue. Liebig, however, pointed out that this experience was because iron was necessary in the making of Prussian blue, that the iron was being obtained by the attrition of the mortars and pestles, and that it would be easier as well as more economical to provide iron in small scraps than to wear it away from expensive machinery.

Waste may be complete and irrevocable as in the case of fire and of shipwreck in the deep sea, or it may be partial and local. What is waste in one place may not be waste in another. The use of a large quantity of wood as fuel in town might be extravagance, whereas the use of the same quantity in the country where there was no sale for it and where land was being cleared, could not be so considered. The use of a small cupful of water for washing one's face would in some countries be the luxuriousness of a sybarite, whereas where water is plentiful such a quantity would be considered totally inadequate.

The raising of pigs may in one place be the greatest economy, in another place deplorable waste. Pigs, more than most animals, eat the same kind of food as man, and in their growth they consume about three times as much as they provide in the way of food. In so far as they eat real refuse their raising is an economy, but often very good food is thrown out of which use could be quite readily made. In Germany this seems to have been recognized according to the report of Sir Wm. Goode of the British Ministry of Food; for while the pre-war total of cattle 21,828,000 was diminished during the war by 2,182,800, or one-tenth the whole, pigs which were 25,341,000, decreased 19,305,750, or more than three-quarters. A factor in the case was doubtless the need of fats for munitions, but certainly another factor was that food was used by humans that had previously been given to hogs. In Canada, on the other hand, there has been an increase notwithstanding the large exportation. In 1914 there were less than 3,500,000 swine in the Dominion; in 1918 there were nearly 4,300,000. Food that could not possibly be exported and used by soldiers and civilians in Europe was changed into bacons which could be easily carried and contained large food value in small bulk.

In farming it cannot be called waste to take two acres for raising the amount of wheat which can be raised on one, if the raising on two acres is less expensive in time and money; but it is waste anywhere to allow half the wheat that is raised, to be destroyed by smut if this can be prevented by a little care; it is waste that hog cholera, as in the United States, has destroyed millions of hogs yearly; it is waste if, as was estimated by the Department of Agriculture, there was in 1910 a loss of $45,000,000 in the United States due to improper handling of eggs on the farm, in transport and storage. At the price then quoted for eggs, this meant that three dozen were lost for every man, woman and child in the country.

The waste most to be deplored is waste of material of which there is a limited supply. Such waste is familiar to those interested in mining and metallurgy. Coal and iron may be considered typical cases.

The loss of coal in Britain some years ago may be taken as an example. Henry Louis says that the output in Britain in 1913 was 287½ million tons. Of this about 20 million tons, or some seven or eight per cent., was used in the collieries themselves. This fraction of the total was used in order to get the rest for general consumption. This is too large a portion, and might be diminished if the less valuable coal were turned into gas and if groups of collieries were supplied from one central gas plant.

There is a quantity of coal left in the mines that might be brought up. Louis mentions cases where coal dust lay several inches deep. This coal dust could be used for firing boilers and furnaces as was done in Westphalia. Dust has the additional drawback that it renders the mine dangerous, explosions being frequently caused by it.

In some mines only the best portion of the seam is taken out and the rest is left behind. This, however, is not a reserve stock to be taken out later. Mines fall in or get filled with water, and the probability is that what is left will never be recovered.

A greater amount of coal than necessary is often left for support in the mine. When wooden props become expensive coal is frequently left to take their place. Thus the loss of coal is dependent on the cost of wooden props and this upon the lack of afforestation. Loss in taking out coal is partially avoided by the use of machinery, which has the additional advantage of increasing the output of each workman.

Loss of coal by fires called gob-fires[1] due to spontaneous ignition of small coal has been considerable. Work carried on in the laboratory of the Doncaster coal owners has given results which should prevent such spontaneous ignition in the future.

Small coal is often left in the mine as not being worth taking up, though it is perfectly good and might be used locally. In some places 20 per cent. is lost in this way, and even 40 per cent. has been left below as of inferior quality. Louis says that legislation might be applied to prevent this waste, but improved methods for using such inferior coal would better meet the situation. Since Louis wrote this article there has been some improvement.

In connection with iron smelting there has been in the past a large waste which is not yet diminished as it should be. In blast furnaces coke is very largely used, and originally, coke in being made was the only product, all the volatile matter escaping or burning at the mouth of the kiln. Now by-product coke ovens are used to a considerable extent, and ammonia and other valuable products are obtained at the same time as the coke. In this way a saving is attained, but the process is still wasteful for the amount of heat given off from these ovens is very much more than it should be. The retorts in which the coal is coked are made of material which does not conduct heat rapidly and a great deal of heat is wasted which should be usefully employed.

In the mining of ore for metals there is often a great deal of waste material. A large amount of the ore at Cobalt has been mined for the silver alone but when full use can be made of the arsenic, nickel and cobalt, these constituents will be saved from waste.

A very striking example of a waste product is given in the manufacture of the incandescent mantles for gas burners. These mantles are composed of almost exactly 99 per cent. of thoria and one per cent. of ceria, any greater or less amount of the latter being detrimental, but the Brazilian monazite sand from which they are made contains only about 6 per cent. of thoria while it confains 30 per cent. of ceria. Therefore, in the process large quantities of ceria are a waste. A small amount of this waste ceria together with lanthana, which is found to about the same extent in the monazite sand, is now employed in the manufacture of pyrophoric alloys. These are used for making gas lighters which act somewhat upon the principle of the old-fashioned flint and steel and take the place of matches.

Next to the waste of material which cannot be renewed, is the waste of material which requires a long time for renewal. Of this a very typical example is given by the forest. The waste caused by forest fires may be complete, and even where it is not actually complete it is often practically made so because the burnt area is neglected until what is of value is lost.

In wood sawn for lumber there is a loss of approximately two-thirds, between the tops and branches left in the forests, the logs sunk in the streams, and the waste in cutting at the mill. A log which could quite well furnish boards thirteen feet long has a foot cut off since boards are marketed in even lengths only and short pieces are wasted, for boards must be not less than ten feet long. Moreover, a board seven inches wide must be cut down to six, since the width is not allowed to be an uneven number of inches. This waste in the mill is followed by a further waste, when boards are cut down to make boxes and furniture.

Unnecessary decay causes a tremendous waste of wood. Eighty per cent. of the destruction of wood is due to decay. Wood preservatives are employed to a certain extent to counteract the organisms causing decay, and even as far back as 1908, fifty-seven and a half million gallons of creosote and nineteen million pounds of zinc chloride were used in the year for impregnating railway ties, bridge timbers, paving blocks, etc.

Co-ordination and co-operation among those cutting down the forests for different purposes would lessen the waste. For instance, the parts of the tree best suited for cooperage purposes are useless for lumber and yet often trees are cut down with only one purpose in view and parts are wasted that could provide just what is requisite for the other purpose. Meat skewers are made of hickory and could very well be made from what is waste for other uses, instead of from trees cut down for the special purpose. If sawmills were put in subsidiary works such as pulp mills, cooperage plants, box factories, etc., much waste might be avoided. Such co-ordination would work advantageously both ways, since poor material which is now made into low-grade lumber might be better used otherwise, waste would be largely eliminated, and material which is now left in the woods to increase seriously the danger of fire would be brought out and usefully employed.

There are said to be 30,000,000 cords of waste material in the sawmills of the United States each year. About half of it is burned as fuel; much of the other half is often burned merely to get rid of it. A small portion has recently been made into wood flour by grinding the sawdust between millstones or steel rollers. Two or three years ago, some 20,000 tons were said to be thus employed annually. White, or at least very light, wood is necessary, such as poplar or conifers without resin. Wood flour is used for the quite different purposes of the manufacture of dynamite and of linoleum. For dynamite it must be very absorbent to prevent leakage of nitroglycerine. The material does not need to be so carefully chosen for linoleum; the cement with which it is put on is the expensive part. From sawdust and blood a material can be made which is capable of being worked like wood, and sawdust is employed in the making of porous flasks used by the Arabs for cooling water. The clay is mixed with sawdust and when the flasks are fired the sawdust is burnt out, thus leaving the ware porous.

It was said above that wood flour is made from non-resinous conifers. From the dead stems and stumps of resinous pines, turpentine can be extracted by various processes, but up to the present these processes are too expensive to allow this wood turpentine to supplant that obtained by the tapping of trees kept for the purpose. It may be noted here that two Australian chemists are recently reported to have obtained a number of very fast dyes from a by-product of the distillation of eucalyptus oil, called "blackwater," which has been hitherto allowed to run to waste.

In the making of wood pulp for paper, there is a great deal of organic matter lost. In the United States, two and a half billion pounds of such material is discharged into streams each year, and is not only lost, but is poisonous to fish. There would be a great advantage if a satisfactory use for it could be found. Alcohol can be produced from it; the important thing is to get a process by which the alcohol can be made a little more cheaply.

In this connection the use that has been made of waste yeast is interesting. An article appeared a couple of years ago under the title "Buttons a By-Product of Beer," in which a description is given of the use made of spent yeast which had been a waste product of breweries. This yeast has a high food value owing to the albumen content, and, when the bitter material furnished by the hops is extracted, can be manufactured into very tasty food products for human consumption besides being a suitable feed for cattle. Apparently

[1] The word gob-fires illustrates how a word once part of the general and classical language may become localized and specialized. Gobbet or the rarer form gob, is found in William Langland's Piers Plowman, in Chaucer and in Wycliffe's Version of the Bible where we find *"Thei tooken the relifs of broken gobbets twelve cofyns ful."*

the amount of yeast furnished by breweries has been found insufficient, and plants have been erected with vats of huge size, sixty feet or more across, in which the yeast scum is some ten feet deep. Not only is this yeast of food value, but when the nutritive portions are extracted there remains a cellulose which when combined with aldehyde and pressed, forms a material which can be sawn or turned in a lathe and polished and is an improvement on horn or bone for the making of buttons, collar studs and such articles. It is difficult to attach metal to horn or bone, but into this material when first formed the metal shanks can be pressed and they adhere firmly. The substance to which the name ernolith has been given can be made hard and brittle or softer and more elastic. This industry which was first started for the purpose of using waste yeast is now extended, the yeast not being the waste product but the means of making use of waste products.

Materials are often allowed to run to waste because so diluted with water that recovery would be unprofitable. Such are liquors from sugar refineries, distilleries, paper works, starch works, etc. These liquors can, however, be inoculated with a rapidly growing form of yeast which produces no alcohol. The yeast grows on the carbohydrates, and in order to provide the necessary nitrogen for formation of the albuminous matter ammonia salts are added. Perhaps the most valuable use of this yeast is as fodder for cattle. This process has been perfected in Germany and it is possible that it can be applied to the sulphite wood pulp waste.

From textile manufactories the waste substances are a great nuisance in rivers. Soap is an important constituent of this waste and it carries other organic matter with it. At Mülhauser this material is precipitated by lime and the solid is compressed into bricks which are heated in gas retorts and the gas obtained has three times the illuminating power of coal gas. The gas is used for lighting the factory and there is a surplus for other purposes. By another process the soap itself is recovered. It may be noted that in the early days of the soap industry, glycerine, which is made at the same time, was a waste product. But glycerine is now so necessary for munitions that during the late war the Germans were almost at their wit's end to procure fat required for the nitroglycerine used in various explosives.

The Germans, urged by the necessities of war, made use of a number of materials little if at all employed before. As is pretty widely known now by the ordinary newspaper reader, coal tar is the starting point for many explosives, dyes, and medicines. It is heated and various substances are charged into vapors which pass through pipes and are again condensed to liquids or solids. In the retorts where the tar is heated and distilled a hard residue, pitch, is left after the other substances have passed off. Pitch has been little used, but owing to the shortage of coal, the Germans have powdered the pitch and have used the fine dust for burning in a blast of air, as coal dust is burned. It has a greater heating power than coal dust, leaves no ash, and acts like oil. Pitch is also made into bricks and used as domestic fuel in stoves and furnaces.

The Germans, it is said, have also found a native plant which gives a fibre equal to that of jute for making rope; and from the fibres of the nettle they have made a cloth which is lustrous and soft. From leather scrap they extract the tannin and the residue makes a very good nitrogenous fertilizer, taking the place of nitrates and ammonia, while the tannin extracted is valuable.

We have been led naturally from the consideration of wood waste to waste occurring in other industries. At iron furnaces in Britain great banks have accumulated of slag which is now being used for the making of bricks and is a specially good material for tarred macadam roads for motor traffic, while melted slag blocks are used for pavement.

In this connection it may be mentioned that at one time iron ore containing more than a small faction of one per cent. of phosphorus was considered valueless. But a process was invented by which phosphorus could be removed from the iron into the slag and thus ores containing phosphorus were made available. The phosphorus in the slag is mainly in the form of phosphate and is valuable as fertiliser. It was considered till very lately that no phosphate in the slag was useful as fertiliser unless it could be dissolved by citric acid and thousands of tons of phosphate slag were dumped into the sea. But during the war, experiments in Britain have indicated that this "made in Germany" test is fallacious, and now what was formerly drowned in the depths of the sea is scattered upon the surface of the land. And now having been led thus far afield by our consideration of forest waste, we are brought back to agriculture again.

One source of waste in agriculture is the growth of weeds, which not only diminish the crop from five to twenty per cent., but in some cases by their poisonous properties destroy animals. In the U. S. national forests alone in 1916, there were 6,648 cattle and 16,273 sheep killed by weeds, and in addition horses, goats and other animals. It is said that hay fever could be almost eliminated by efficient methods for controlling weeds found along roadsides and in waste places.

Weeds form hosts for many of the worst plant diseases; for instance, the white-pine blister-rust which is threatening several hundred million dollars' worth of pine forest is due entirely to the presence of forest weeds belonging to the genus *ribes*. Such insects as the cotton boll weevil usually spend the winter in weeds allowed to grow round the border of the fields.

Wood control is essentially a problem of co-operation; agricultural clubs and other farmers' organizations could probably undertake no more important work than that of controlling weeds. The advantages of community work for control of weeds cannot be too strongly emphasized.

The damage done by the cotton boll weevil is a notable example of the ravages of insects. A district round a town in southern Mississippi in 1908 produced 31,812 bales, and in 1911 only 3,168 bales. The cotton boll weevil was an obscure pest on wild plants in Mexico, but when introduced into the cotton district developed into one of the most disastrous pests of the South. In the particular district mentioned the growing of cotton was given up altogether and dairy farming taken up instead—fortunately, with success.

Many of the insect pests are importations. The following quotation is from an article by E. A. Back in the Year Book of the United States Department of Agriculture for 1917. "Twenty years ago, in the Yearbook for 1897, Dr. L. O. Howard, Chief of the Bureau of Entomology, began the campaign against the careless and unintentional introduction of pests from other countries through the ordinary trade channels. The need then expressed for national legislation establishing quarantine against foreign insects has been demonstrated only too well by the new and injurious pests that have since become established in America. Fortunately the campaign to protect the United States from insect-infected and diseased fruits and plants has led at last to the passage of such a law as the Federal plan quarantine act of 1912. But it has taken much painful and expensive experience to educate public opinion to the point where such legislation was made possible. Apple growers have had to fight the codling moth and the San Jose scale; wheat growers the Hessian fly. New Englanders have had to see their forrests devastated by the gypsy moth, and to suffer from the poisonous rash of the brown-tail moth. The western farmer has had to see his alfalfa fields devoured by the alfalfa leaf weevil; the orange and grape fruit growers of Florida have had to suffer from the devastating spread of the white flies through their groves; cotton growers have had to lose millions of bales of cotton to feed the cotton boll weevil; the Californian years ago had to see his trees almost ruined by the cottony cushion scale, and more recently householders and others in large portions of the South have had to see their premises overrun by that diminutive scourge, the Argentine ant. What farmer of the South does not know of the tremendous losses caused by certain grain weevils? What railroad president or farmer of the eastern portion of the United States has not seen his chestnut forests dying within the past few years from the chestnut blight? Yet all these pests and many more have come to our shores from other countries through the usual channels of international trade. They will tax forever the agriculture of our country."

The danger of introducing these pests increases year by year with greater traffic and with fruits brought in cold storage. On the Pacific Coast there are fruit fly inspectors to examine the baggage of passengers from Hawaii and each passenger has to take an affidavit that he has in his baggage no fruit subject to fruit fly attack. Fruits of no value are sometimes brought home as curiosities and occasionally introduce insect pests. The study of insecticides is becoming important but while insecticides may prove a partial cure, in this case an ounce of prevention is worth a pound of cure.

Fruit that may be unfit for packing may still be of value. There is sometimes as much as ten per cent. of the oranges and grapefruit of Florida that form culls; and efforts more or less successful have been made to make use of them. The preservation of the juice by pasteurisation and the recovery of the flavoring oils from the peel by vacuum distillation seem to be commercially feasible and likely to become common.

The house rat is probably the most destructive animal in the world. Quite apart from the destruction of human life by plague propagated by rats, which has been greater than that caused by all the wars of history, the yearly damage in town and country amounts to a tremendous sum. It is estimated that each rat in a year destroys a value of two dollars, and placing the rat population in the United States equal to the human population, which is probably a low estimate, the annual loss would be $200,000,000. To make up this amount would require the labor of about 200,000 men and if valued in grain would require about 10,000,000 acres for its production.

The making of houses and farm buildings rat proof, and the careful protection of food, are among the best means of combating rats, but in addition the employment of traps, and of dogs and sometimes of cats is to be recommended. Hawks and owls prey on rats and do not destroy one-sixth as much poultry as the common brown rat does and yet a bounty is given in some States for each hawk killed, without even making certain that the species is one that destroys poultry. Owls hunt at night and are especially effective ratters.

Seaports are liable to be rat-infected. Recently over a hundred thousand rats were killed in two or three British ports. Twelve thousand of these were examined for plague and seven were found to be plague infected.

The consideration of rats naturally leads to the subject of garbage and its utilisation. If the term is employed to include not only wast food but waste of all kinds from houses, ashes form a very considerable item. According to analyses made in New York City in 1907, the ordinary ashes from stoves and household furnaces contain nearly one-third of combustible matter. This would give in New York a loss of nearly three-quarters of a million tons of good coal which can be recovered at a cost of about two dollars a ton and the ashes left can be used with other materials for the making of Portland cement or brick for paving purposes. The ashes have also a certain value as fertiliser, containing themselves only a little of the required elements, but useful mainly as an absorbent for fertilising material.

Considering that part of garbage which consists of inedible portions of vegetables or animals, processes have been employed for extracting the grease and using the remainder as a poor kind of fertilizer. There are processes also for burning the material and to a certain extent using the heat for power purposes. No very efficient method of garbage disposal has been contrived, no method which is sure not to cost more than it produces.

The waste caused in garbage should therefore be diminished at the source. Pieces of bread and bits of meat do burn to produce heat which can be used to run electric motors, but bread and meat are very expensive forms of fuel. During the late war, thrift and economy have been inculcated by the governments of all countries, wastefulness has been branded as a crime instead of being looked upon as an attribute of large-hearted generosity. Saving has been encouraged as a virtue and a patriotic duty. The United States Department of Agriculture has sent out a pamphlet on wastes, each page of which is headed by the proverb "Many a nickle makes a muckle," emphasizing the importance of avoiding small wastes. If each family in the country wastes only one slice of bread a day it would total 1,500,000 barrels of flour a year which would require nearly 500,000 acres for its production. An ounce of meat each day for the 20,000,000 families would amount to 228,000 tons in a year. That this is not an excessive estimate for the waste but is rather below the mark is probable, since the total consumption for each person is over a hundred pounds a year. It was given as 150 pounds a year in 1907, but is doubtless less now.

It has been stated in the newspapers that since the restriction of the food supply in Britain, the girls are healthier and of a more brilliant complexion than before, and if this is so, not only has food been wasted by being thrown into the garbage pail, but it has been wasted by being eaten. The waste occurring in this way cannot readily be estimated.

Many articles are thrown upon the rubbish heap or into the garbage pail that would be of value. I have seen the photograph of a room, the walls of which were covered with clocks which had been thrown away as useless but were repaired and made serviceable.

In one of the humorous illustrated papers there were, not long since, contrast pictures 1914 and 1918. In the former a shabby and dilapidated individual with an empty bag over his shoulder approaches a house only to find the notice "no rags or papers or bottles." In the latter a portly and prosperous person steps from his automobile to the door where is displayed a conspicuous placard "call for rags or bottles or papers." The junk dealer has during the last few years come into prominence. Before the war, the junk business in

(*Continued on page* 304.)

What the Weather Man Thinks of Ocean Flying*—II

Trans-Atlantic Flight from the Meteorologist's Point of View

By Willis Rey Gregg, Meteorologist of the U. S. A. Weather Bureau

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In order to determine, under given conditions of wind, the direction toward which an airplane should be headed in order that it may keep to any desired course, and the resultant speed along that course, it is only necessary to resort to that elementary principle of mechanics, applicable to any body moving through a medium which itself is in motion, viz., the principle of the composition of speeds. For example, in figure 2 let *OB* represent a course which an aviator desires to follow, and *OA* or S_w the speed of the wind, this wind making an angle α with the line *OB*.

Also, let S_a represent the air speed (i. e., speed in still air) of the airplane.

The the angle β which the airplane should make wih OB, in order that the latter shall be the resultant course, may be readily computed, since the sines of the two angles are inversely proportional to the two speeds, or

$$\sin \beta = \frac{S_w \sin \alpha}{S_a}.$$

Also, by completing the parallelogram, we find graphically the resultant speed, or $S_r = S_w \cos \alpha + S_a \cos \beta$.

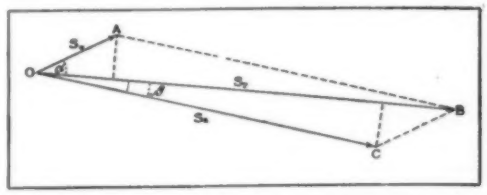
To take a typical case, suppose the desired course is E. 5° S.; wind bearing and speed are E. 25° N., 10 meters per second (about 22 miles per hour); and the air speed of the machine is 40 m. p. s. (about 90 m. p. h.). Then $\alpha = 30°$.

$$\sin \beta = \frac{10 \times \sin 30°}{40} = .1250$$

$$\beta = 7°, \text{ or } OC = \text{E. } 12° \text{ S.}$$

Also $S_r = 10 \times \cos 30° + 40 \times \cos 7°$
$= 48$ m. p. s., or about 107 m. p. h.

From the foregoing brief discussion, it is evident that, with an airplane of known air-speed, the successive directions toward which the machine should be headed and the total distance covered in a given time (or the time required to fly over a given course) are quickly and easily determined, providing the prevailing wind conditions are known. The great difficulty consists in finding out, at any specified time, just what these wind conditions are. This is being done very successfully at a large number of places in this country with kites carrying self-recording instruments known as meteorographs and with small rubber "pilot" balloons, whose movements through the air are followed by means of theodolites. The data thus obtained are telegraphed to the Central Office of the Weather Bureau, and bulletins are issued for the information of aviators in the Aerial Mail Service, Army and Navy Aviation Services, etc. Another method of determining wind conditions that has been used in the war and at ordnance proving grounds, is by means of so-called "Archie" bursts, which consist of puffs of smoke from a shell, the fuse being so timed that the shell bursts at any desired altitude. The movements of these smoke puffs are observed in a graduated mirror and the wind directions



Course and speed of an airplane in a quartering wind

and velocities at the given height are readily computed. When low clouds are present several shells are sent above the clouds at stated intervals, usually half a minute apart, an airplane of known speed flies from the first smoke cloud to the last, and the aviator is thus able quite accurately to determine the current wind conditions and to set his compass course accordingly. Still another method used in France during cloudy weather consists in sending up small balloons which carry small charges of melinite so arranged that they burst successively at regular intervals. Sound telemeters record the explosions, and the position in space of the points of detonation can be thus determined. All of these methods are comparatively simple on land; they are less so at sea, yet some of them at least are by no means impossible, except in very stormy conditions. For example, a notable series of observations with pilot balloons was made by Teisserence de Bort and A. L. Rotch from the deck of their steam yacht *Otaria* in 1905-1907. The ascensional rate of the balloons was known and the angular positions of the balloons were observed by means of a sextant from minute to minute. Moreover, the observations on the *Scotia* and on the *Seneca* show that kites can be used at sea with fair success. For observations by any of these methods it is advisable that the ship remain as nearly as possible in one position. Hence it would be impracticable, or at any rate difficult, to utilize trans-Atlantic steamships for this purpose. The best scheme would be to have at certain intervals along a proposed route several small ships that could make and report such observations. These ships would also be able, by means of radio communication, to act as guides for an aviator and, in case of accident, to provide a means of rescue. In order to be successful, trans-Atlantic flight, at any rate in its earlier stages, should certainly have the benefit of such assistance. Aside from the uncertainty as to wind conditions, there is the added difficulty of keeping to a course, partly because of the deflective influence of the earth's rotation and partly because of lack of precision in the compass itself. With clear skies sextant observations make possible the correct determination of position, but in cloudy weather the compass is the only guide unless the aviator can fly high enough to get above the clouds. Eventually difficulties of this sort will very likely be overcome by the perfection of radio apparatus of sufficient power to enable an aviator to keep in constant communication with points in both Europe and America. Even then, however, wind conditions along the course should be known as accurately as possible.

In case free-air observations are unavailable, there still remains the possibility of obtaining reports of surface conditions. Such reports could and should be furnished not only by specially detailed ships but also by those regularly plying between American and European ports. With these observations the meteorologist would be able to draw a synoptic weather map showing the surface conditions of pressure and wind that prevail at a given time, and from this map wind velocities at an altitude of 500 to 1,000 meters could be quickly determined usually with fair accuracy, from the well-known equation for gradient winds, viz.:

$$v = \sqrt{\frac{r\,dp}{\rho\,dn} + (r\mu \sin \phi)^2} \pm r\mu \sin \phi,$$

in which v = velocity in centimeters per second,

$\frac{dp}{dn}$ = difference in dynes pressure per square centimeter per centimeter horizontal distance at right angles to isobars,

r = radius of curvature of the isobar at the place of observation, in centimeters,

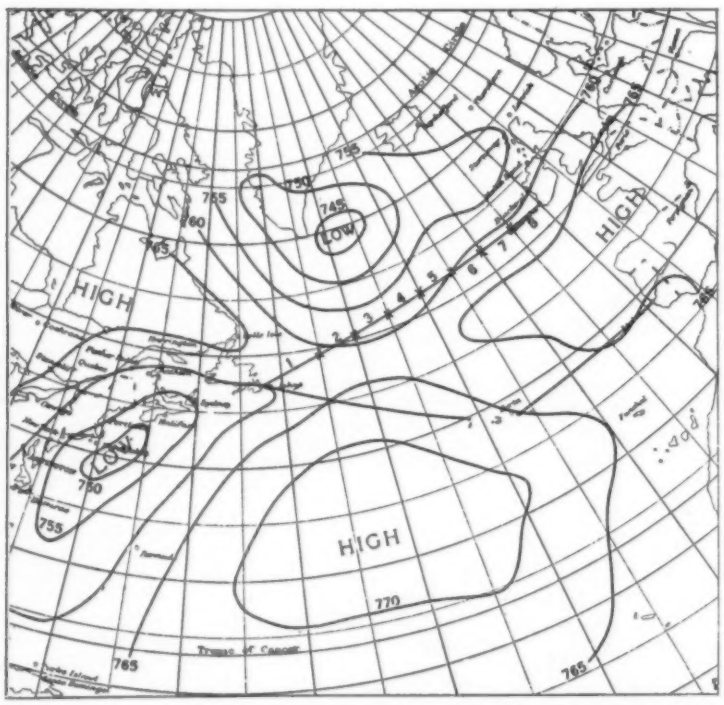
ρ = air density in grams per cubic centimeter,

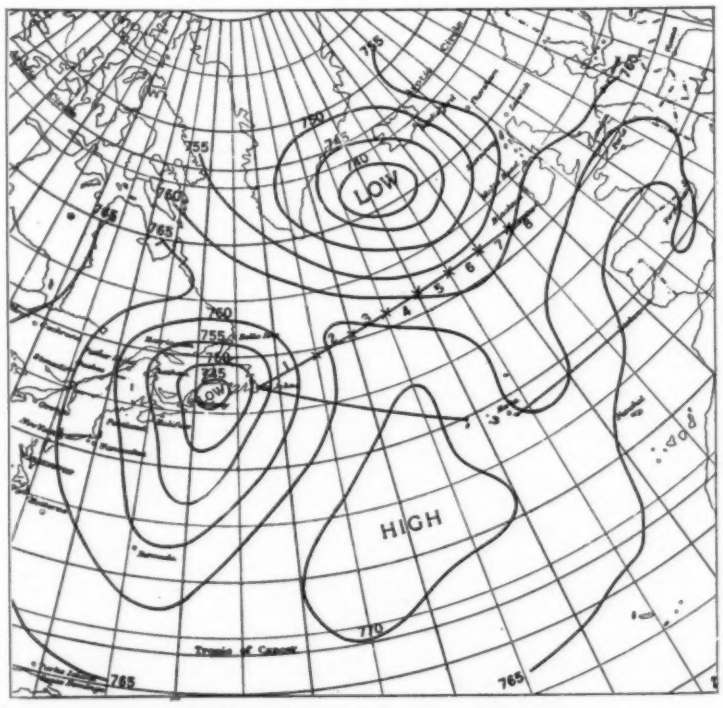
μ = angular velocity of the earth's rotation $= \frac{2\pi}{86164}$

and ϕ = the latitude.

As previously stated, wind directions at these altitudes are usually found to be very nearly parallel to the isobars. When pressure conditions are well defined and relatively stable, comparatively small error is introduced in accepting the foregoing assumptions, but when they are very irregular or when local disturbances, like thunderstorms, squalls, etc., are occurring, the principle of gradient winds must be used with caution. In general, it is more reliable over ocean than over land surfaces, because, as already pointed out,

*Appearing in the *Monthly Weather Review*.





Typical pressure changes over the North Atlantic for 24 hours. The map represents conditions at noon on May 29 and 30, 1906

isobaric systems are larger and move more slowly over the oceans than they do over the continents.

It is not sufficient, however, for the aviator to know the *current* wind conditions. He must also be informed as to the *changes* that are likely to occur during the latter part of his trip, and this may be as much as 20 to 25 hours in advance. Here again the meteorologist is assisted by the fact that isobaric systems over the ocean are relatively slow-moving. With this in mind and from a detailed study of the map before him he can construct a series of maps showing expected conditions at intervals of six hours, for example. From this series of maps he is able to determine the probable wind conditions that will prevail at successive points along the course at the times at which the aviator is expected to reach those points, these times being dependent, of course, on the air-speed of the machine and on the assistance furnished by the winds.

For the purpose of illustration let us consider a type of pressure distribution that is not uncommon, and endeavor to trace out the wind conditions at an altitude of 500 to 1,000 meters along a great circle course from Newfoundland to Ireland. The time selected is the 24-hour period from Greenwich mean noon, May 29, 1906, to the same hour on May 30, 1906. The first map shows the pressure distribution prevailing at the beginning of this period and the second shows that prevailing at the end of the period. On these maps are also indicated the great circle courses from Newfoundland to Portugal via the Azores. In the study an attempt has been made to trace the changes in the pressure distribution by means of intermediate maps, but these are not reproduced here. The flight is supposed to start from Newfoundland at about 2 p. m., 60th meridian time, or about six hours after the observations charted in the first map were made. About this much time would normally be required for the receipt and interpretation of reports.

The table gives in some detail the results of this study. The course has been divided into eight sections as indicated by crosses in the figures and these sections are listed in column 1 of the table. Columns 2 and 3 give corresponding bearings and distances; columns 4 and 5 computed gradient wind directions and speed (22); column 6, the directions toward which the airplane should be headed in order to keep to the courses indicated in column 2; column 7, resultant speeds; and column 8, the time required to cover the successive sections of the entire course, providing the airplane maintains a constant air-speed of 40 m. p. s.

Section.	Bearing.	Distance.	Gradient winds.		Airplane headed.	Resultant speed.	Time.
			Bearing.	Speed.			
		Km. (miles).		m. p. (m. p. s. h.)		m. p. (m. p. s. h.)	Hrs.
1	E. 22° N.	630 (395)	Variable.	... (...)	E. 22° N.	40 (90)	4.3
2	E. 17° N.	375 (235)	E.	8 (18)	E. 30° N.	48 (107)	2.2
3	E. 12° N.	355 (220)	E. 17° S.	14 (31)	E. 2° N.	52 (116)	1.9
4	E. 9° N.	345 (215)	E. 5° S.	16 (35)	E. 16° N.	55 (123)	1.7
5	E. 5° N.	340 (210)	E. 9° S.	19 (39)	E. 11° N.	55 (123)	1.7
6	E. 2° N.	330 (205)	E. 6° N.	16 (36)	E.	56 (125)	1.6
7	E. 1° S.	330 (205)	E. 15° N.	16 (36)	E. 8° S.	55 (123)	1.7
8	E. 5° S.	345 (215)	E. 23° N.	14 (31)	E. 14° S.	52 (116)	1.8
Total		3,040 (1,890)					16.9

Briefly, this table shows that, through the assistance given by the winds, the entire trip from Newfoundland to Ireland could have been made in about 17 hours, whereas in still air about 21 hours would have been required. This period would have been fairly favorable also for the journey by way of the Azores, although less assistance would have been furnished by the winds than along the northern route. In general, "favorable" conditions for the eastward and westward trips along the two routes may be thus summarized:

(*a*) Newfoundland to Ireland: High pressure at latitudes 35° to 45° N. and low pressure at latitudes 55° to 65° N. with axes extending from west to east, so that isobars run nearly parallel to the latitude.

(*b*) Newfoundland to Portugal via the Azores: High pressure at latitudes 30° to 40° N., central near the Bermudas with crest extending eastward, and low pressure at latitude 50° N., central about 1,000 kilometers east of Newfoundland. Under this pressure distribution isobars extend east-southeastward from Newfoundland to the Azores, thence eastward to Portugal.

(*c*) Ireland to Newfoundland: Reverse the conditions given under (*a*).

(*d*) Portugal to Newfoundland via the Azores: Reverse the conditions given under (*b*).

In all cases, the greater the pressure gradient, the greater would be the wind assistance. Occasionally there is found a high-pressure area at about latitude 45° N. with its axis extending from west to east. This condition would be favorable for both the eastward flight by the northern route and the westward flight by the southern route. An unfavorable day for any of the journeys would be one on which conditions are the reverse of those stated under (*a*), (*b*), (*c*), and (*d*), respectively. Another type of pressure distribution unfavorable for all the journeys and one which often occurs, especially during winter, is that in which low pressure extends as a troughlike depression from north to south across both routes. Under this condition winds almost at right angles to an airplane's course would be encountered and would materially reduce the resultant speed.

In order to determine as nearly as possible the average number of days on which favorable conditions might be expected for the four journeys during different months, all of the daily marine synoptic weather maps for the 10-year period, 1906 to 1915, inclusive, have been examined and classified. This classification has been made by Messrs. F. G. Tingley and George Paterson of the marine section of the Weather Bureau and by the writer of this paper. Each one inspected about a third of all the maps for each month, after having first compared results on a number of maps inspected independently by all three. In this why it is believed that errors of personal judgment have been reduced to a minimum. The basis of classification is as follows: An excellent day is one on which assisting winds prevail at all points along the route so that the advantage in time is about three hours or more; a good day, one on which assisting winds predominate, although head or cross winds prevail part of the way, the assistance giving a gain in time of one to three hours; fair, one on which the proportion of favoring winds is slightly greater than that of head or cross wnds, so that the time required for a flight is nearly the same as if there were no winds whatever; and poor, one on head or cross winds predominate or one on which very stormy conditions prevail. The results of the classification, dropping from further consideration the two classes designated fair and poor and combining the first two classes into one group as constituting all of the days that are favorable for trans-Atlantic flight, appear in the subjoined table.

	Newfoundland to Ireland.	Newfoundland to Portugal.	Ireland to Newfoundland.	Portugal to Newfoundland.
January	15	9	1	6
February	10	9	0	2
March	10	9	2	3
April	7	7	2	3
May	12	11	2	3
June	10	6	2	3
July	13	8	3	4
August	13	8	1	2
September	9	8	2	3
October	11	9	0	3
November	6	6	1	4
December	11	11	1	3
Spring	29	27	6	7
Summer	35	22	6	8
Autumn	27	23	3	10
Winter	36	29	2	10
Annual	127	101	17	35

From this table it is at once apparent, as was to be expected, that but little assistance from winds can be gained for the westward trip along either the northern or the southern course. For the eastward trip, however, such assistance may be expected approximately one-third of the time, the percentage of favorable days being slightly greater along the northern route, due to its lying entirely within the region of the prevailing westerlies. A detailed study of the data upon which these tables are based shows that favorable days occur on the average along the northern route 35 per cent. of the time, with extremes in different years of 25 and 47 per cent.; along the southern route the average is 28 per cent., and the extremes 20 and 39 per cent. When considering the monthly values we find very large variations in the same months for different years. For example, in July, 1906, there were 28 favorable days for the trip from Newfoundland to Ireland, whereas in July, 1907, there were only 4. This and several similar cases give emphasis to the statement previously made that pressure systems over the oceans are slower moving than over the continents. Persistence of certain pressure types, with little change from day to day, is a marked characteristic of conditions over the Atlantic and should give no little comfort to an aviator who is about to undertake a flight, after having waited for days or perhaps weeks for a favorable opportunity to start.

The foregoing classification has been based on the assumption that the flying level is about 500 to 1,000 meters above the surface. At greater altitudes, as already shown, the percentage frequency of westerly winds rapidly increases and, therefore, the percentage of favorable days for an eastward flight would become larger, probably increasing to 70 per cent. or more at the 3-kilometer level. Conversely, the percentage of favorable days for a westward flight would decrease although it is difficult to imagine a much smaller percentage than that indicated in the table. The whole question as to the altitude most suitable for flight is still largely in the experimental stage, and the solution depends upon a thorough analysis of the various factors that enter in. For example, it is frequently found that the greatest wind assistance would be realized at an altitude of 5 or even 8 to 10 kilometers, but, on the other hand, the greater tenuity of the atmosphere at those levels would reduce the efficiency of the engine and the lower temperature and lack of oxygen would add to the discomfort of the aviator, thus making such altitudes prohibitive. Probably at the present time the most favorable height, all things considered, for trans-Atlantic flying is between 1 and 3 kilometers above the surface for the eastward trip and about 500 to 1,000 meters for the westward trip.

It is recognized, of course, that there are other meteorological factors, besides wind conditions, that enter into the determination of the relative favorableness or unfavorableness of a day for flight, such, for example, as cloudiness, precipitation, etc. Except in so far as landing is concerned, however, wind is the one element of paramount (and, at the present time at least, most vital) importance. Cloudiness and precipitation do not extend to very great heights over the ocean, because the high relative humidity causes condensation at a lower level here than over the land. As a rule, therefore, an aviator would be able to fly above these conditions, particularly if they covered relatively small areas. On some days stormy conditions prevail over a considerable portion of the ocean, and such days, as already stated have been classed as unfavorable. In this connection it is interesting, and at first thought somewhat surprising, to find that the winter season shows up so well for eastward flight as compared with the other seasons, but it should be remembered that whenever conditions *are* favorable during that season, they are decidedly so, because of the greater strength of the prevailing westerlies at that time of year. Many days in summer, otherwise excellent, have only light and variable winds and have therefore been classified as fair. The transition seasons, spring and autumn, have, on the other hand, more quiet days than does winter. Hence, the percentage of favorable days is less than during the two extreme seasons.

In this paper attention has been confined for the most part to the application of meteorological conditions over the Atlantic Ocean to flight with heavier-than-air machines. The statements made apply equally well to airships. These, however, by reason of their greater capacity for fuel, and owing, moreover, to the fact that they are not dependent on motive power to sustain them, are capable of remaining in the air a relatively long time and are therefore not so vitally dependent upon favorable wind conditions as are airplanes.

CONCLUSIONS.

1. In the present stage of their development and until improvements give them a much larger cruising radius than they now have, airplanes cannot safely be used for trans-Atlantic flight except under favorable conditions of wind and weather.

2. Observations of conditions over as great an area as possible, and particularly along and near any proposed course, should therefore be available at as frequent intervals as possible, these observations to include free-air as well as surface conditions.

3. With such observations at hand the meteorologist is able quickly to determine the current and probable future wind conditions along a proposed route and to advise an aviator as to the suitability of a day for a flight.

4. If a day is favorable, the meteorologist is able to indicate the successive directions toward which an airplane should be headed in order to keep to any desired course; also, to calculate the assistance that will be furnished by the winds.

5. Inspection of marine weather maps shows that at an altitude of 500 to 1,000 meters conditions are favorable for an eastward trip approximately one-third of the time, the percentage being slightly greater along the northern than along the southern route. At greater altitudes the percentage of favorable days materially increases, especially along the northern route. For the westward trip the percentage of favorable days is so small as to make trans-Atlantic flight in this direction impracticable until the cruising radius of aircraft is increased to such an extent that they are relatively independent of wind conditions.

6. All things considered, conditions for an eastward flight are most favorable along the northern course; for a westward flight they are most favorable along the southern course; that is, the prevailing westerlies are less persistent along this course than farther north.

7. There seems to be little choice as to season, for, although the prevailing westerlies are stronger in winter than in summer, yet on the other hand, stormy conditions are more prevalent in winter, and the net result is about an equal percentage of favorable days in the two seasons. Moreover, the greater fog percentage in summer just about offsets the greater per-

centage of cloudiness in winter. Fog is a disadvantage chiefly because of its interference in making observations with drift indicators. The Newfoundland fogs in general are of small vertical extent and do not extend far inland. They should not, therefore, prove a hindrance to landing, if the landing field is located some distance from the coast.

8. Most important of all, there is need for a comprehensive campaign of meteorological and aerological observations over the North Atlantic in order that aviators may be given data for whose accuracy the meteorologist need not hesitate to vouch, instead of information based on so small a number of observations, particularly of free air conditions, that the deductions, including some of those in this paper, are assumed and not proved, are given with caution, and are "subject to change without notice."

America and German Science

WE have already, on more than one occasion, directed attention to the effect exerted by the war on American opinion concerning German science and on the marked change it has brought about in the attitude of American men of science towards their German *confrères*. The change is the more remarkable in that it is contrary to what might have been anticipated from the leaven of Teutonism which exists in the United States, and from the possible influence of German university-trained men on American education and on American technology. It is well known that the German Government confidently counted upon this element to restrain America from participating in the world-wide struggle upon which it had embarked. As usual, it miscalculated. The "hyphenated" American, who had thrown in his lot with his adopted country, and learned to know and to appreciate its institutions and its ideals, had, with comparatively few exceptions, no real sympathy with Germany's unscrupulous designs to dominate the world and to impose its "Kultur" upon mankind. Where it was well with him, there was his country. Of course, there were traitors, for the most part controlled and instigated from Berlin, but, looking back upon the past, it is remarkable how small their influence was in modifying American opinion, or in thwarting American action.

Public opinion, indeed, thoroughly supported the American Government in its prompt and energetic dealing with covert attempts to undermine the loyalty of American citizens, or with overt acts to injure or terrorize them by outrage and crime. Such attempts, so far from achieving their object, had precisely the opposite effect. An act of outrage and terrorism like the destruction of the Lusitania, with its awful loss of life, did more to rouse and stiffen American feeling than any single measure that could have been conceived. As Fouché said, it was more than a crime; it was a political fault, and that of the most egregious kind. The extravagant jubilation with which the crime was everywhere hailed in Germany was the finishing touch to the episode, and greatly intensified the wrathful indignation and disgust of civilized humanity. It was significant that the American troops should go into action with the battle-cry of "Lusitania!" and that intellectual and cultured America should visit its resentment upon those of its own class in Germany, who, so far from protesting against this affront to our common humanity, shared the general joy of their countrymen that it had been committed.

Recent attempts to dissect the mentality of German men of science have accentuated this feeling. They and their works have been put through a scrupulous assay, with the result that they are no longer taken at their own valuation. The scales have fallen from people's eyes. In various papers and articles which have appeared in American scientific periodicals we have been given the results of the analysis, and, to say the least, they are not flattering to German self-esteem. Dr. Nutting, in a recent issue of *Science*, describes the methods, "some of them entirely legitimate by every standard, others entirely indefensible by any standard," by which Germany has sought to establish her prestige in pure and applied science. Whilst America in the past respected Germany's diligent productive workers, and contributed, with some qualms of conscience, rather freely to German scientific literature, she smiled at her many false claims to superiority and originality, and generally despised her technologists for their piratical methods. With the coming of the war she was surprised to find how well she got along without her, and how little she was really indebted to her. Whilst it is true that the scientific and technical output of Germany was greater in proportion to population than in any other country, it is not true that scientific ability or originality is higher in native-born Teutons than among other civilized races. This, indeed, has been admitted by such an authority as Pro. Emil Fischer, who, in an address before the German Emperor four years before the war, had the courage to point out to him the shortcomings of the Teutonic mind in originality and creative power. How, then, has Germany gained the prestige she has undoubtedly enjoyed? Dr. Nutting attributes it to what he styles "the intensive factor of publicity"—in other words, to intensive self-advertisement, conscious or unconscious. And he proceeds to indicate in what this has consisted.

It must be admitted that the Teuton mind has the faculty of application—more, perhaps, than that of any other nationality. "A specific problem occupies it to the exclusion of almost everything else. While we (Americans) are prone to work a few hours, then turn to something else, or run off to play, the Teuton eats and sleeps with his problem, takes little interest in anything else, talks shop with his colleagues, and does not completely relax even in his limited recreation."

Our author claims that his compatriots are as ready as any to attack difficult scientific problems, and they are not wanting in incentive. "What we do lack is the 'follow through' thoroughly to search out and master a problem in all its details, generalities, and side issues, before turning our attention to new problems. To minds teeming with ideas all clamoring for attention it is not easy to ignore the many that a few may receive fuller attention." How true this is may be seen by contrasting the methods pursued in German schools of chemistry, where a single conception is hunted to death, as it were, by the professor and his pack of collaborators, who follow it through innumerable ramifications, like a harried hare. It would constitute an interesting statistical exercise to determine the number of Ph.D.'s which have been created by chasing special ideas, with the professor as a whipper-in. Of course, the method is not without its advantages in the interests of knowledge, but its real *educative* value may be doubted, and it certainly does not conduce to develop any latent creative power in the student. It is more frequently directed to serve the interest of the professor than that of his pupils.

Another source of Germany's prestige arose from the comparative cheapness of printing and publication in that country. Struggling men of science eked out a meagre salary by compiling books which were readily accepted for publication on a narrow margin of profit. New serials and journals, and works of reference, were easily started, to find their way into university libraries and state-aided institutions throughout the world as more or less authoritative and indispensable.

The output of scientific and technical literature, good, bad and indifferent, was, in fact, prolific.

Dr. Nutting contends that alien students, university professors, and technical men working in Germany have aided greatly in building up her scientific prestige. These aliens, he calculates, represented fully 10 per cent. in each class—"clear 'velvet' to her, and a corresponding loss to their own countries." The students came, he states, in about equal numbers from Russia, England, and the United States, with a few from Scandinavia, Switzerland, and Japan, but scarcely any French or other Latins. The inducements were easy matriculation and graduation, while fees and living expenses were very moderate—barely half those at Oxford or Cambridge. "The instruction itself was hardly worth any special effort, but it was accessible, and it differed from the home product."

German universities have in the past drawn freely upon foreign countries for their instructors. It has been estimated that a third of the more noted German men of science were foreign-born—Russians, Dutch, and Swiss. These, for the most part, soon became Teutonized, and were thereafter regarded as Germans. The Jews, too, whom the typical Teuton regards as aliens, and secretly dislikes and despises, have contributed in no small measure to the fame of his universities.

German capitalists have always welcomed and been ready to exploit technical men of ability, no matter of what nationality, and a large proportion of the better-known German manufacturers have originated in France, Italy, England, or America.

Such are the main factors which, in Dr. Nutting's opinion, have contributed to Germany's scientific and technical prestige. "Plagiarism and piracy," he asserts, "were common practices, and from personal knowledge I doubt whether a third of even the more eminent German scientists were free from this taint. Further, the work of foreigners was taught as the work of Germans in both literature and science. Neither fairy tale nor scientific discovery, if in an obscure publication, was safe from adoption as their own, while the misleading of the young student was easy and common."

Alienа optimum frui insania. American men of science have the wisdom to profit by the errors of the enemy. The war has taught them how to mobilize their man power and to organize their forces of productive achievement. They will, however, not take over that particular code of ethics or standard of literary and scientific morality and conduct by which modern Germany, in her too eager desire for wealth and power, has lowered herself in the estimation of the civilized world.

Revegetation

W. H. BROWN, E. D. Merrill and H. S. Yates contribute to the *Philippine Journal of Science* an account of the "Revegetation of Volcano Island, Luzon." This island is about 25 sq. kilometres in extent, surrounded by the waters of Lake Bourbon, which separate it from the mainland. Prior to the eruption of Taal Volcano in 1911 the vegetation appears to have been chiefly grass and small trees (more especially *Saccharum spontaneum* and *Ficus indica*). As a result of the eruption most of the vegetation was destroyed, except in the northern part of the island, where a number of bamboo clumps and some bananas survived, relicts of the former villages.

The chief invading species in the recolonisation are grasses, but even after six years the vegetation is still only sparse, probably owing to erosion, the low water content, and high proportion of sulphates present in the soil. The following list embraces those species which are enumerated as very common and widely distributed: *Acacia farnesiana*, *Antidesma ghæsembilla* (eaten by birds), *Bulbostylis barbata* (eaten by animals), *Callicarpa blancoi* (eaten by birds), *Eugenia jambolona* (birds and man), *Ficus hauili* and *F. indica* (both eaten by birds), *Ipomœa pescaprœ* (water), *Morinda bracteata* (? by water, eaten by birds), *Pithecolobium dulce* (eaten by birds), *Saccharum spontaneum* (wind), *Tabernæmontana subglobosa* (birds), *Trema orientalis* (by birds). Of the total of 292 vascular plants recorded since the eruption, 54 per cent. have probably been introduced by the agency of birds, about 20 per cent. by wind, and about 10 per cent. by water. The order of importance of these three agencies is thus the reverse of that for the revegetation of Krakatau, a difference that is probably to be attributed to the much longer distance of travel. So, too, with respect to the pioneer species, the role played by the lower cryptograms, which in the case of Krakatau was considerable, is here insignificant.

The lichen *Bilimbia arthytoides* and a few mosses and hepatics attain a limited and local abundance in the damp ravines, but blue-green algæ have not been observed.—*Scien. Progress.*

Manganese Alloys in Open-Hearth Steel Practice

No information is available to the writer bearing on the use of manganese-silicon alloys in electric-furnace practice, but we may at least consider such practice on the basis of the known behavior of such alloys. Considering acid casting practice first, there seems to be no reasonable doubt that either silico-manganese or silico-spiegel could be at once substituted for ferromanganese and ferrosilicon. Inasmuch as the usual aim is to make high-grade castings, the manganese-silicon alloys would appear to have the distinct advantage of making sounder and cleaner steel. Silico-spiegel, aside from possessing the theoretical advantage of being diluted with iron, could be more readily prepared with the correct manganese-silicon ratio so as to eliminate the use of an additional alloy. In this practice the advantage of greater dilution need not carry with it the disadvantage of increased weight on account of the higher temperature of the electrical furnace. The uncertainty of our knowledge as to the relative behavior of the manganese-silicon alloys as compared with that of the ferro alloys, and the relative efficiencies of low-grade and of high-grade alloys, as well as the importance of this step in the manufacture of steel, suggest the advisability of conducting a definite research to settle such points. It would seem that there is no better place for such a research than in this particular industry.

In basic electric-furnace practice the manganese-silicon alloys, on the same grounds, could likewise be utilized, particularly as the attempt is always to produce sound and clean ingots. However, in this practice, ferrosilicon is used as a reducing agent along with coke, and hence the operator would probably not see any advantage in changing his practice in favor of the manganese-silicon alloys.

The Selling of Patent Rights*

Methods by Which an Inventor May Obtain Satisfactory Returns from His Patent

By Ford W. Harris

THERE may be said to be three steps in the process of putting a patented article on the market, namely, inventing the article, securing a patent on it, and organizing a company with the financial means required for its manufacture. A great deal has been written about the first two steps, but very little information has been published about the third, which is the subject now to be considered.

Let us assume that the inventor has an invention of real practical value, and that he has a patent on it and is ready to place the invention on the market. How should he proceed to interest manufacturers or capitalists, and what kind of trade should he expect to make? The market for an invention depends on what the invention is; and what applies to one kind of patent decidedly will not apply to another. However, there are a few rules which apply to all inventions.

PATENT SELLING AGENCIES.

Every inventor receives immediately upon the issue of his patent, many circulars from concerns that pretend to be engaged in the business of selling patents. If they are investigated it will be found that they one and all want a fee in advance. It may be two dollars or it may be several hundred, but the fee is the first subject they broach. Sometimes the fee is for a write-up, sometimes it is for a cut of the invention, and other times it is for advertising matter, but the main principle is that you pay them some money and they do some work. They will not guarantee to sell your patent nor will they make the original fee contingent on a sale. So far as the writer has been able to determine, all these concerns are failures in so far as getting results is concerned. They take the fee and do about what they advertise to do, but they rarely make a sale. The reasons for this are more or less obvious.

INTERESTING THE MANUFACTURER.

One reason is that nearly every patent has a limited number of possible buyers. Manufacturers are engaged in making a certain product, and if you go to them you must show them something that relates in some way to the thing they are making or to the machinery which they have. It must be of such a nature that their sales force can handle it, and it must be of such a nature that the factory can readily turn it out with the tools and other machinery on hand. If you are going to sell to an established manufacturer you have two problems—first, to find someone who can handle the invention, and second, to interest him when you do find him.

It has been the writer's experience that it is a very difficult matter to attract a man's attention by corresponding with him. A great deal has been written about sales letters, but the only really successful way to sell anything that requires actual salesmanship is to see the prospect, and tell him the truth in such a way that he will believe it. Consequently, form letters scattered broadcast to several hundred manufacturers are usually barren of results. Few business men read letters that do not relate to something they are interested in. If they know the man who wrote the letter, or if they are already interested in the subject, a letter receives attention, but new matters do not receive much attention when presented by mail, and certainly will not obtain a hearing if they come in an unsealed envelope with all the other marks of a form letter. Sending out form letters is about all the so-called "patent brokers" do, and the inventor can do just as well himself at much less cost. The writer's advice, however, would be, to save the postage.

ASCERTAINING THE VALUE OF PATENTS.

Before submitting the patent to a manufacturer, or indeed before doing anything at all with it, it is wise to find out just how broad a field it covers. It must be understood that a patent consists of two parts, namely, a description, accompanied usually by a drawing which tells the public how to use the invention, and one or more claims that state just what part of the article described cannot be used without paying royalty to the inventor. So far as discriminating buyers are concerned, the patent resides wholly in the claims, and many patents have narrow or even worthless claims. The patent should be taken to a patent attorney, and a full explanation obtained from him as to the scope and effect of the claims that he has obtained for the inventor. Bear in mind that a claim is an exact description of the thing another person cannot make without infringing on a patent, and that anything that the claim does not describe will not be an infringement. The shorter the claim the better; and the fewer the elements and the more broadly they are stated, the better the patent.

*From Machinery.

SALESMANSHIP REQUIRED IN SELLING PATENTS.

Having the patent to sell, there are really two courses to be followed unless, of course, one happens to be so fortunate as to have the money to go ahead himself without asking for financial help. One is to interest a manufacturer, and the other is to interest capital to finance the manufacture. To interest the manufacturer, it is first necessary to find the man who is able to handle it. If it concerns a certain line of business, it will pay to study that line a little if one is not already familiar with it, in order to determine who are the principal concerns interested in that particular line. Pick out a man who has a good reputation and ask for an interview. In talking to a manufacturer, or indeed in trying to sell an invention to anyone, try to leave as little to the imagination of the buyer as possible. In other words, if you are trying to sell a patent on a carburetor, have a real carburetor ready to show him; do not expect him to take your word that it will work as you say it will. Have it ready to put on a machine and demonstrate. Also, do not leave off important parts or submit a rough model and expect to obtain a good hearing.

The more complete and thoroughly worked out the invention is, the more likely is the prospect to be interested. Also, the more tangible and material things that are exhibited, the easier it is to sell. For example, you may well have snapshots showing how the invention works or how it is installed; you may have letters from prospective customers; or, better yet, you may have actual or contingent orders for the device. Or, again, you may have a letter from your patent attorney advising you that you have a good patent and one that will prevent others from making certain classes of devices, and to supplement it you might show a letter from an entirely independent attorney saying much the same thing.

Now you may not be an experienced salesman, but if you are an inventor you have one thing that makes up for lack of experience in salesmanship, and that is the fact that you understand your invention and have faith in it. That is the first essential to selling anything, and it is a convincing factor. If you have picked the right man and your invention has real merit you will be able to interest him. If you cannot interest him, assume that he is not the right man and try another. It may be necessary to try several times before you locate the right man. Try to find out, however, why each prospect turns you down, as his reason for rejection will give you a line on how to overcome the same objection if another person raises it, and will also show you whom to approach next.

DIFFERENT PLANS OF SELLING PATENT RIGHTS.

Having found your man, what sort of trade can you make with him? Here, again, only general rules can be given. You can sell the invention outright or you can place it on a royalty. Many concerns will not pay royalty, preferring to figure out carefully just what the invention will probably be worth to them and either buying it outright or rejecting it.

If it is a matter of a cash sale, there are only two rules for selling anything, namely, get as much as you can and do not be too greedy. The latter rule applies with peculiar force to inventors who see only the millions that may be made. It is well to seek unbiased and expert advice as to values. If you have friends who have good business judgment, try to get them to figure out what the invention ought to be worth to the particular manufacturer you are dealing with. Try to estimate the probable market and the profits but do not let your imagination run away with you.

If you have a prospect that wants to take the patent on a royalty basis, see that he agrees to pay you a minimum royalty. That is, see that he agrees to pay you a certain sum every year or every three months or six months whether he makes and sells any or not. Also see that he recognizes the validity and utility of your patent and that he agrees to pay his royalty on or before a certain day. If the royalty period is one year, it is well to make the contract for only one year and make it automatically renewable if the minimum royalty is paid and the other conditions lived up to. Then you do not have to take anything away from him—he simply does not renew his rights. The whole object of minimum royalty is to prevent anyone from taking over the invention and not working it. Sometimes a man wants to keep an invention out of the market, and by agreeing to pay royalty on any of the articles that he makes and then not making any, he will succeed in shelving the invention. Consequently, the minimum royalty should be just big enough to prevent such shelving.

BASIS ON WHICH ROYALTY CONTRACTS SHOULD BE MADE.

Royalty contracts are usually made on a basis of a certain per cent. of the retail selling price, or in some cases on a percentage of the price obtained by the manufacturer. A much better arrangement is an agreed amount per article. In some cases the inventor agrees to take a certain proportion of the profits. This is usually a very poor arrangement, as the inventor is in effect and usually in fact a partner, and may become liable for the debts of the business; and in any case he has to find out what the profits are, which is often a matter for much argument and contention. The manufacturer should agree to keep an accurate account of the number of articles sold and to report and remit at stated times. He should also agree to allow the inventor free access to his books during business hours, and should agree to swear to the correctness of the books and the reports if required to do so.

Sometimes it is possible to give the articles consecutive serial numbers, which makes the accounting easier, and sometimes the inventor furnishes nameplates or labels at so much apiece, which the licensee affixes to the article. It would seem at first sight that the collecting of royalties would be a difficult matter, but with a properly drawn contract it is just as easy to keep track of and collect royalties as it is to collect any other debt. The royalty contract should be drawn by a patent attorney who is experienced in such matters. The main considerations are to see that the contract is definite as to what is to be done, and the exact time that it is to be done, and to provide that if it is not done, all rights shall revert to the inventor. This requires some knowledge of state law, and the patent attorney should also be an attorney-at-law, admitted to practice in the State in which the contract is made.

THE TERRITORIAL-RIGHT PLAN OF SELLING PATENTS.

The character of some inventions makes it difficult to sell them outright or place the invention on a royalty. Some inventions can be handled on the territorial-right plan. For example, patents on road or concrete construction readily lend themselves to this plan. It is possible, with inventions of this kind, to sell state or county rights, and some inventions can be sold for even smaller territory. This plan proves profitable in many cases, as there are a great many counties, for example, in the United States, and a small amount per county will aggregate a surprisingly large sum. In these cases, the inventor sells the entire and exclusive right to make, use, and sell the invention within a specified territory. In other cases, a mere shop right may be granted, or rights may be sold which are not exclusive. There is one great advantage with the latter course, and that is that where an inventor is willing to license all manufacturers to make and sell the invention, and where he is satisfied with a small royalty, there is not much incentive for any manufacturer to infringe. In fact, it may be said to be a general business policy to grant licenses to all comers upon a small royalty, if the licensee agrees to maintain prices. Usually where a number of competing manufacturers are willing to enter into such an agreement it is found to be very profitable, as they are able to raise the price of their product a sufficient amount to more than pay the small royalty demanded. Such agreements are of doubtful legality, but there are a number of industries in which it is common practice.

POSSIBLE INFRINGEMENT ON PREVIOUS PATENTS.

The inventor often is unable to interest a manufacturer, and it is necessary for him to actually embark in the business of making and selling his invention. If he has the money, there is nothing to mark such a business venture from other lines of business unless it be the hazards which are peculiar to patents. For example, most men believe that if they have a patent, they are free to go ahead and make the thing pat-

ented. This is a mistake that has cost many a man all he had. It is entirely possible, and even very common, for a man to have a patent on a thing that he cannot make without infringing on patents owned by others. This is due to the fact that his patent is a narrow one covering an improvement on something to which another holds broader or dominating patents.

Before going into the business of making and selling an invention, all legal questions should be settled as well as the probable market and possible price. If you are sure that it is legal to make the thing and that there is a market with a probable good margin of profit you are justified in organizing your business. It is not really so important to have a broad patent yourself as to be sure that you are not going to infringe some other fellow's patent; but it is wise, before you start, to assure yourself that your patent is going to keep others out of the field when you get it developed. It is also wise to keep your patent attorney informed as to your progress and to file new applications as fast as new ideas occur to you that may be legitimately patented.

CONCLUDING REMARKS ON THE SELLING OF PATENTS.

Sometimes, and indeed in the majority of the cases, it is necessary for the inventor to seek financial help elsewhere before he can start in the business of exploiting the patent. Considering the proposition purely from the standpoint of the inventor seeking capital to exploit a genuine invention, several things may be said. In the first place, it is advisable to carry the work of perfecting the invention as far as possible with one's own resources. For example, you have an idea for which you have not applied for a patent. It is very hard to induce anyone to invest money on a mere idea, and even when they do, they will ordinarily want a half interest. If you have spent your own money in applying for a patent you have shown your own faith in the idea to that extent, and you are in a better position to trade. If your patent has been allowed, you are in a still better position. If you are able to exploit the invention yourself, even in a very small way, so that the probable cost, margin of profit and demand can be shown, you are in a still better position to deal with capital.

Further, it is much easier to get a partner than it is to sell for cash. If you have an invention and want to sell it for $10,000 you will find it much harder than it is to get some man to put the same amount in the business for a half interest. In the former case, he figures that you are anxious to get out, and becomes suspicious; in the other, he considers that you must have faith in the invention, since you are trying to retain a half interest. If it is a real invention, it is always worth more than you can legitimately get for it, and it is wise to retain it until it is on the market, when you can usually find some concern or man who is in a position to handle it to good advantage and who will pay a satisfactory price.

Prosthesis of the Lower Limb

(*Continued from page* 291)

In a true Syme's a sufficient vertical depth exists below the end of the stump for the point to be placed at the level of the normal ankle. If the malleoli have been left the joint must be placed in the lateral steels outside the boot.

Chopart's amputations are often unsatisfactory; in about half the cases the action of the tendo Achillis and the tibialis posticus causes the foot to assume a position of equino-varus when the patient walks on the anterior end of the os calcis and astragalus. If the position of the foot is satisfactory a leather casing is moulded accurately to the foot and ankle and attached to the instep of the anterior half of the foot. Side steels are usually necessary; these should be jointed opposite the ankle-joint to permit of free flexion.

STANDARDISATION.

Finally comes the question of standardisation. The large number of artificial limbs required has caused attention to be directed towards the possibilities in regard to this. The chief advantage to be gained from standardisation is the ease with which a damaged part can be replaced; a certain saving of money will also be effected, but only slight, because the cost of a limb is due not so much to the expense of the material as to the cost of labor. Another advantage would be the possibility of ensuring the same quality of material in each limb.

It is obvious from what has been written above that standardisation of the bucket is impossible, but standardisation of the component parts of the limb is possible in many cases.

The Army, before and in the earlier stages of the war, was composed of men of more or less similar physique; certain standards as regards height and chest measurement were maintained, with the result that the physique of the average soldier ranged within circumscribed limits. Even later in the war when these standards were more or less abandoned, by a process of more or less conscious selection, the men in the fighting line were in most cases similar in physique to those of the earlier Armies.

On analysis of the measurements of men with amputations it was found that, excluding about 15 per cent. for the purpose of fitting artificial limbs, the sizes of the various parts required could be grouped into four—four sizes of feet, four sizes of leg-pieces, and four sizes of knee-pieces. With these three parts 64 combinations can of course be made.

The four sizes of feet correspond with Nos. 7, 8, 9, 10 sizes in boots. The leg-pieces are of such a form as to be suitable for the tall thin man, the man of average height and proportions, the short stout man, and the bantam—i. e., the small, well-proportioned man. It is the exception for a tall man to possess a big calf. A fat man over 6 feet in height probably suffers from some physical disability which would prevent h's being accepted as a soldier; the tall very muscular man with a well-developed calf would be included in the 15 per cent. of exceptions. The four sizes of knee-joint correspond with the different sizes of leg-pieces and feet.

One size and form of ankle-joint suffice for all sizes of the other parts. The knee-bolt, with side plates fastening on to the leg-pieces, are made in four sizes, corresponding with the different sizes of the knee-piece.

Another part which it is possible to standardise is used for below-knee amputations: this is the side steels for which one size only suffices.

Some Things That Might Be Used

(*Continued from page* 299)

the United States amounted to about $100,000,000 yearly, but at a meeting of waste-material dealers in the autumn of 1917 it was announced that the business amounted then to $1,000,000,000. Part of this increase was due to increased value, part to increased quantity.

For years the thrifty housewife in Europe has gathered old rags and papers and metal ware that the average American has not thought worth saving. Two million dollars' worth of rags of one kind was imported yearly for a particular grade of paper which the American bought at a high price and which was ordinarily burned after use, though it could quite well have been made over into paper for use once more. Almost any kind of paper or rags can be employed for the manufacture of some grade of paper. From one-fifth to one-third of the paper manufactured is made from old paper, and some seven or eight per cent. from rags; and doubtless a larger proportion would be made of these materials if they were more commonly saved. The value of some kinds of rags increased eight-fold during the war, as the export from Europe was limited if not entirely stopped. Waste metal, too, became more valuable. Scrap iron which had been two dollars a ton rose to ten or twelve dollars. Doubtless the householder who had only small amounts to sell did not get these high prices, but still there was a considerable advance. Charitable organizations made a considerable addition to their funds by collecting junk that people were glad to give them.

A paper on saving should, I suppose, not omit the mention of daylight saving. Apart from the method we have employed for universal daylight saving, I have noticed that a paint firm advertises its paint as saving as much time as three-quarters of an hour of daylight by its lustrous properties and pure brilliancy. It is certainly true that the color and character of walls and ceilings in a room make a difference in the amount of light required; and, what is of more importance, have an effect upon the eyes, and it is also said upon the brain and mind.

It might well be considered whether economy in study might not be advantageous. Do children need to spend so many hours a day in school? It certainly is a waste of time for them or for anyone to force the eyes to keep open over a book when the brain is weary and the mind is closed. This subject is, however, too large to be considered here. There are two sides to the question. Study cannot be compressed into too little time. Hurry is not necessarily a saving of time. The mind needs time for the maturity of ideas. But it does not seem necessary to spend as much time as we do in the mere work required for the support of life, just that we may have enough to eat and wear. Why should not three or four hours a day suffice for that? Why should we not have the rest of the time for a rational enjoyment of life? Why could not people buy all that they need during four or five hours of the day? If some people can do their shopping only in the morning and some only in the afternoon why should not some of the stores be open from eight to one and others from one to six? The rule suggested for the so-called working man, the laborer skilled or unskilled, might very well be applied to the professional man whose work is usually more arduous. Why should a doctor, for example, work all day and all night? Surely the country would be better off if our sanitary and other conditions were such that doctors could get through their routine work in two or three hours and have the extra time for research and recreation. There would be no necessity that the physician should starve under these conditions for the community could certainly afford to pay as much to be kept well as is now paid for the still unsatisfactory condition of our general health.—*Queen's University, Kingston, Ont.*

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Table of Contents

	PAGE
Prosthesis of the Lower Limb	290
Keeping the Propeller Dry.—By M. E. Dunlap	292
The Magnetic Field of the Sun	293
Changes of Ocean Level.—By W. M. Davis	294
The Cedars of Lebanon.—By A. Henry	295
Flowers and Tiny Animals in Glass	296
Agricultural Possibilities of the Sahara	297
Some Things That Might Be Used.—By John Waddell	298
What the Weather Man Thinks of Ocean Flying—II.—By W. R. Gregg	300
American and German Science	302
The Selling of Patent Rights.—By Ford W. Harris	303

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Y.

PAGE
290
292
293
294
295
296
297
298
300
302
303